Electricity Privatization:
Should South Korea Privatize Its State-Owned Electric Utility?

By

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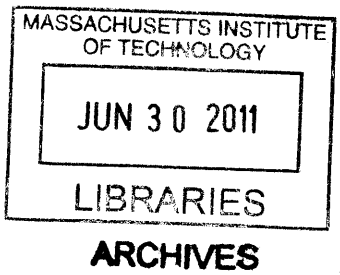

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Abstract

The state-owned electric utility, Korea Electricity Power Cooperation (KEPCO), privatization has been a key word in South Korea since 1997, when the government received $55 billion from the International Monetary Fund in exchange for a tough economic restructuring that included massive privatization. The Korean government separated KEPCO's six generation subsidiaries from KEPCO in 2001 in the initial process of the privatization. However, the government has not taken any further action since then. While there have been debates about the privatization of KEPCO, the debates were political rather than economic. This thesis will investigate whether or not Korea should continue to privatize KEPCO. First, it will examine how much revenue the government can make by selling its shares of KEPCO. Second, this thesis will study how much investment a privatized electricity industry will attract after privatization. Third, it will identify whether the electricity price will go down if the government privatizes KEPCO. Fourth, it will assess how the relationship between the government and the industry will change after privatization. Finally, it will identify how much does the government and people have to pay for the transition, which is caused by the change from a monopoly to a competitive market. By comparing the advantages and the disadvantages, this thesis will decide whether the advantages outweigh the disadvantages. This thesis will discuss only economic aspects; it will not examine the political, social and cultural aspects which are difficult to measure objectively.

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Chapter 1: INTRODUCTION

Privatization has become a key word in both industrialized and developing countries since the 1980s. Electric utilities have become one of the key areas of privatization because of their enormous economic influence on national economies. Some developed countries that respect competition, such as the United Kingdom, privatized their electric utilities and introduced competition in the early 1990s. On the other hand, other developed countries, including France, have kept government-owned electric utilities. Developing countries have been privatizing government-owned electric utilities mainly to attract foreign investments, enhance the quality of services, and lower prices.

Massive privatization of state-owned enterprises, including the Korea Electric Power Corporation (KEPCO), was a part of Korea's economic restructuring after the 1997 currency crisis. The Korean government announced that it would receive $55billion from the International Monetary Fund (IMF) in exchange for a thorough economic restructuring in December 1997 (Kim, 2002). The Korean government separated KEPCO's six generation subsidiaries from KEPCO and established a wholesale electricity exchange regime in 2001. However, it is difficult to say that Korea actually privatized KEPCO because the government is still the major shareholder and influences most of KEPCO's management; private parties, who own 40 percent of the shares, have little influence on KEPCO management.

While the Korean government has not taken any further action since 2001, KEPCO's privatization has long been a controversial issue. However, few studies have been conducted to understand whether the country should fully privatize KEPCO. The debates are always among politicians, government officials, government think-tanks or ordinary

people. For example, a presentation about KEPCO restructuring organized by a government-supported research center, the Korea Development Institution (KDI), was interrupted by the citizens from a provincial city. The citizens thought that a subsidiary of KEPCO might not move to their town if KDI's research was accepted (Song, 2010).

This thesis will investigate whether Korean should privatize KEPCO. First, it will examine how much revenue the government can make by selling its shares of KEPCO. Second, this thesis will study how much investment the privatized electricity industry will attract after the privatization. Third, it will identify whether the electricity price will go down if the government privatizes KEPCO. Forth, it will identify whether the electricity price will go down if the government privatizes KEPCO. Finally, it will identify how much cost does the government and people have to pay for the transition cost, which caused by change from monopoly to a competitive market. By comparing the advantages and the disadvantages, this paper will decide whether the advantages outweigh the disadvantages. This thesis will discuss only economic aspects; it will not examine the political, social and cultural aspects which are difficult to measure objectively.

Chapter2: THE MEANING OF KEPCO PRIVATIZATION

2.1. Laws regulating Korean electricity service

Korean law regarding electricity business is the Electricity Business Act. All kinds of electricity businesses, such as generation, transmission, distribution and retail services, can enter the market under this law. However, all new entrants have to obtain licenses, which are subject to the government's discretion. The government has allowed only KEPCO and its six power generation subsidiaries to enter the electricity market for several decades.

The Korea Electric Power Cooperation Act stipulates the establishment, ownership and business of KEPCO. According to the act, the Korean government owns more than 51% of the company's assets and the Minister of Knowledge Economy exercises the stockholder's right.

The Electricity Industry Restructuring Promotion Act was enacted to divide and privatize KEPCO in 2000. However, this act lapsed in 2009, leaving no significant effect other than establishing six power generation companies owned by KEPCO and a government agency, which decides real-time electricity market price. This change can hardly be regarded as the introduction of competition because the six companies are KEPCO's subsidiary companies.

Many acts are related to electricity services such as the Electricity Business in Rural Area Act, the Renewable Energy Act and the Collective Electricity Business Act. These acts are not studied in this thesis because they are not directly related KEPCO privatization.

2.2. KEPCO

KEPCO is a typical public company owned and operated by the government. The government owns more than 51% of the total shares and has designated the Minister of Knowledge Economy to oversee its running. The CEO is nominated by the Minister of Knowledge Economy and appointed by the President.

KEPCO has an enormous influence on the South Korean economy, as almost all Koreans have to buy electricity from this company. KEPCO is also important as the second biggest company in terms of assets, and eleventh biggest company in terms of market value in the country. Its annual sales, which were 33.6 trillion Korean Won (₩33.6 trillion)[1] in 2009, represent more than three percent of Korean GDP (see [Figure 1]).

[Figure 1] Annual sales of KEPCO

Unit: ₩ billion

	2,006	2,007	2,008	2,009
Annual Sales	27,408	29,137	31,560	33,993
Annual Profit	3,394	2,821	-2,798	1,714
Total Asset	77,435	82,928	88,198	93,208
Total Debt	34,200	38,661	46,923	51,804
Total Equity	43,235	44,266	41,274	41,403

Source: Financial Supervisory Service (http://dart.fss.or.kr/dsaf001/main.do)

KEPCO is comprised of the main company, which runs transmission and distribution and retail services, and numerous subsidiaries including generation and foreign businesses. KEPCO owns the six biggest power generating companies, such as Korea Hydropower & Nuclear Power Co, Korea East West Power Co and Korea South East Power Co. KEPCO also owns other electricity business entities such as Korea Nuclear Fuel Co, KNOC Nigerian East Oil Co, and Korea Electric Power Data Network Ltd (see [Exhibit 1]).

[1] ₩33.6 trillion is about $30.1 billion.
The exchange rate between US dollar and Korean Won was 1 and 1,115 on March 9, 2011.

2.3 KEPCO operation (Electricity market operation)[2]

Every nation has generators, transmitters, distributors and retailers in its electricity market. As of 2009, Korea has 405 generation organizations including 380 generation business entities and 25 regional, collective and self generators. However, only KEPCO's six generation subsidiaries have meaningful market share. In 2009, they owned 82% of the capacity and generated 94% of the country's electricity generation (See [Figure 2]). Other companies' power generation increased from 4.66% of total generation in 2002 to only 6.19% in 2009. Transmission, distribution and retail services are monopolized by KEPCO (MKE, 2011a).

[Figure 2] Total generation and generation capacity by companies

Generation (MWh)

	1981	1985	1990	1995	2000	2005	2009
Total Generation	44,088,303	62,667,201	118,460,795	203,546,465	290,442,948	389,479,512	454,317,296
KEPCO & Subsidiaries	37,428,005	56,179,998	103,184,998	179,073,203	256,841,584	349,758,383	406,779,556
Other Companies	2,778,660	1,754,007	4,206,029	4,032,626	4,836,511	11,448,962	18,350,447
Group & Alternative	-	-	-	-	-	3,162,645	7,617,607
Non-Utility in Common Use	3,881,638	4,733,196	11,067,768	20,440,636	28,764,853	25,109,522	21,569,686

Generation Capacity (kW)

Total Capacity	11,029,344	17,639,982	24,055,893	35,355,785	53,684,913	67,075,240	77,661,844
KEPCO & Subsidiaries	9,130,580	15,013,903	19,782,833	30,561,633	44,566,083	55,956,412	63,962,287
Other Companies	704,800	1,122,800	1,238,290	1,622,240	3,884,634	4,764,663	6,761,354
Group & Alternative	-	-	-	-	-	1,537,122	2,746,337
Non-Utility in Common Use	1,193,964	1,503,279	3,034,770	3,171,912	5,234,196	4,817,043	4,191,866

Source: MKE, 2011a

[2] As KEPCO is the only transmission, distribution and retail service provider and the owner of the six biggest generation companies, KEPCO operation might be regarded as the electricity market operation. In 2.1.3, both KEPCO and electricity market will be regarded as the same.

In 2009, KEPCO supplied electricity services to 18.908 million customers with 394,475GWh (see [Figure 3]). The average retail price for residential service was 98.09 Korean Won per kilowatt-hour (₩/kWh), and that of industrial service was 73.69 ₩/kWh in 2009 (KEPCO, 2010). According to the International Energy Agency, the price of electricity in Korea is among the cheapest in the world. Retail electricity price in Korea is 0.089 US Dollar per kilowatt-hour ($/kWh), followed by Thailand (0.094 $/kWh), Mexico (0.096 $/kWh), United States (0.113 $/kWh), France (0.169 $/kWh), United Kingdom (0.231 $/kWh) and Japan (0.206 $/kWh) (see [Exhibit 11]).

[Figure 3] KEPCO sales by customers

	Number of Customers	Total sales (thousand won)	sales per customer (thousand won)	Total consumption (GWh, %)
Residential	11,298,000	6,613,500,000	585	57,596(15%)
Public & Service	6,007,000	12,099,700,000	2,014	139,135(35%)
Industrial	1,422,000	14,261,800,000	10,029	197,744(50%)
Total	18,727,000	32,975,000,000	1,761	394,475(100%)

Source: KEPCO, 2010

KEPCO's mid-term and short-term operation plans as well as long-term investment plans are hugely influenced by the government. Long-term plans, such as building new power plants and new high voltage transmission lines, are developed not by KEPCO but by the government itself. The Electricity Business Act stipulates that "the Minister of Knowledge Economy shall adapt fundamental and comprehensive measures to promote stability of the supply and demand of electricity and the comprehensiveness of electricity business" (Article 3) and that "the Minister of Knowledge Economy shall determine the definite contents of universal supply of electricity" (Article 6). KEPCO, on the other hand, manages electricity supply to protect consumers (Article 4) and the environment (Article 5).

The "Fifth basic plan for the electricity supply," which was announced by the government in 2010, is a good example of a government-initiated long-term plan. According to this plan, the government anticipated that the electricity demand would grow 1.9% annually from 2010 to 2024. Based on this anticipation, the government announced that it will build 14 nuclear power plants, 15 coal power plants, 19 gas plants and 8,036km of transmission line by 2024 (MKE, 2010b).

Mid- term plans, such as maintenance scheduling, fuel purchasing plans and retail price adjustment, are left to KEPCO. However, the government can influence the mid-term plan through a CEO appointed by the President or the Board of Directors, which is directed by the Minister of Knowledge Economy. For example, although KEPCO has the nominal authority to decide electricity price, the 2010 Ministry of Knowledge Economy Business Plan reported that it would change the retail price structure (MKE, 2011a). Article 17 of KEPCO Act stipulates that "The electric utility bill --- shall include details of the utility charges specified by their items in such manner as determined by the Ordinance of the Ministry of Knowledge Economy."

In its short term plans and daily businesses, KEPCO has autonomy. However, its operations related to stable and efficient services are strictly regulated by the government. Even the rule of electricity trade between generators and KEPCO is set by a government agency, the Korea Power Exchange (KPE). The Electricity Business Act stipulates that all electricity business entities have to sell and buy electricity through KPE (Article 31). The exchange volume and bidding price are set by KPE. The generators and retailers have no input into this decision-making process. In this system, KPE decides how much electricity should be generated by which generators, selected from the cheapest to the most expensive.

The wholesale prices of each type of generator, such as nuclear, coal and gas, are set by KPE regularly. In sum, KEPCO and KEPCO's generation subsidiaries have no choice but to buy and sell electricity with the quantity and price decided by KPE.

2.4 Privatization

Generally speaking, "privatization" refers to selling government-owned public companies to private parties. In the past several decades, privatization has been implemented by selling government shares to reduce the government's ownership portion of a company. For example, the Korean government privatized numerous public companies such as Pohang Iron and Steel Cooperation and Korea Telecom by selling its shares on the domestic and international stock markets in 2000.

Public ownership of a company is based on a monopoly system and a great number of government regulations on the public company. Privatization, on the other hand, is based on a market competition and a new set of regulations that guarantee competition. In many cases, however, publicly owned companies compete with other companies in the market. It is also possible that a private company monopolizes a market and takes a great number of regulations. In many cases, introducing competition and developing new regulations for the competitive market follows privatization. At the same time, the government has to reduce previous regulations on the newly privatized company to implement privatization successfully.

Privatization does not merely mean selling government's shares of a company on stock markets. The government should decrease or abolish regulations of the newly-privatized company. In some cases -- for example, if a newly-privatized company is in a

competitive market -- the government does not need to regulate the company anymore. No investors will buy the shares of a newly privatized company if the government insists on too much regulation on the company. In many cases, selling government shares to the private sector occurs concurrently with reducing regulation on the company. For example, the Korean government gave up many regulations, such as designating the CEO, when it privatized one of its state owned companies, Korea Telecom.

Another important feature of privatization is that the government should introduce competition in the market, where the newly-privatized companies have monopolistic power. Regulators believe that the newcomers in the market can prevent the newly-privatized company from abusing monopolistic power. In other words, the checks and balances of the competitors will guarantee the socially desirable price and output of the market. For example, when the Korean government privatized the telecommunication company in 1997, it also issued a license to the second land-line telecommunication service provider, Hanaro Telecom. In this way, two companies were created, adding competitiveness to the telecommunication market.

The last step in privatization is developing new regulations for competitive markets, which were not necessary when the government owned and governed the company. This is because a newly-privatized company may have too much monopolistic market power. The newly privatized company might abuse its power and push its competitors out. A newly privatized company, which has all infrastructure, discriminate newly created companies which has less infrastructure. To guarantee competition between newcomers and the newly-privatized company which owns infrastructure, the government has to mandate they share the infrastructure. For example, when the Korean government privatized a public

telecommunication company, it developed a new regulation. Under the regulation, the newly privatized company was regulated to share its infrastructures, such as ducts, cables, poles, or station buildings, with other service providers (Telecommunications Business Act, Article 34-3).

2.5 Electricity privatization

Although there are many types of electricity privatization, MIT economist Paul L. Joskow argues that there are common characteristics (Joskow, 2006). First, privatizations of state-owned utilities decrease political influences on the utilities and increase incentives for their performance. Second, vertically integrated utilities are separated into competitive businesses: generation, transmission, distribution, retail and so on. The separation can be done by dividing a utility into several small companies, or by separately auditing several parts of one company. Third, enough generators should enter and compete in the market to ensure competitive market output. In this point, setting few big markets would be better idea to enhance competition than setting a lot of small markets. Fourth, transmission networks should be integrated to encompass all the wholesale generators. An independent system operator should manage the operation to ensure the stable and fair operation of the whole network. Fifth, competitive spot wholesale markets[3] should be built to support the real time balancing of supply and demand. The competitive spot markets can enhance the system reliability by efficiently responding to unplanned events. Sixth, transparent rules that assure generators to efficiently access to transmission systems should be built to guarantee the fair competition. Seventh, customer bills for the amount of electricity usage

[3] Generators can sell electricity with long-term contract or spot market. Spot market refers to day-ahead and real time markets.

and delivery costs should be divided so that customers can choose their retail service providers. Eighth, an independent regulator should be established. This regulator should have enough information about costs and performances of firms to enforce adequate obligations with the information. Lastly, the government should develop transition mechanisms of a privatization process. For example, the government should decide how to compensate owners of old and inefficient generators, which will not be used in the competitive market.

2.6 KEPCO privatization

KEPCO privatization has been an issue since the 1997 financial crisis in Korea. In November 1997, Korea's foreign currencies were exhausted because of the massive withdrawal of foreign currency. Many foreign investors believed that Korea, following Thailand and Indonesia, could not repay its foreign debts. Because the Korean central bank had not enough foreign currencies, the Korean government had to borrow them from the International Monetary Fund. The Korean government had to fundamentally change its economic system to obtain the financial support. As part of the fundamental changes, the government privatized five of the eleven largest state-owned enterprises and 61 out of the 108 state-owned companies from 1998 to 2000. As hoped, foreign investment in Korea returned, indeed very quickly, from less than US$2 billion in 1995 to US$15.7 billion in 2000.

Korea agreed to privatize KEPCO as a part of the large privatization in the late 1990s. The Korean government created KEPCO's six generation subsidiaries. The government also established the Korea Power Exchange to introduce a wholesale

electricity market mechanism and the Korea Electricity Commission to introduce an independent electricity market regulator (Byrne et al, 2004).

A Korean government official has stated that Korea had tried to sell one of the six KEPCO generation subsidiaries in the early 2000s. However, Korea gave up the plan for four reasons. The first reason was that the generation company, whose assets were 5,468 billion Korean won (4,755 million US dollars), was too big to find a new owner. Second, few investors were interested in the generation company because its profit was too small. Third, the Western Energy Crisis of 2000 and 2001 negatively influenced the policy makers' attitudes on privatization. Finally, the president in the early 2000s did not want too many privatizations (O.H. Lee, Senior Deputy Director of MKE, personal communication, Feb, 2011).

It is difficult to say that Korea actually privatized KEPCO. Although the Korean government regards KEPCO as partly privatized, it retains a great deal of influence. First, the government is still the major shareholder and it sets most strategic plans, such as building new power plants. Even though private parties own 40 percent of the shares, they usually do not influence KEPCO's long-term plan. The second reason is that there is no market competition among KEPCO and its six generation subsidiaries. Even though KEPCO is separate from six generation subsidiaries, and trades with them, prices and quantities are decided by another government agency, the Korea Power Exchange. The last reason is there are few possibilities for new and significant entry into the market. This is because the electricity price in Korea is very low and the government always sets the price close to the marginal generation cost.

Chapter3: THE EXPERICENCES OF ELECTRICITY PRIVATIZATION

3.1. Chile

Chile is the first country in the world that privatized its state-owned electric utilities. The Chilean government established the competitive electricity market by enacting the General Law of Electric Services in 1982 and privatized state-owned electric utilities after 1986 (Pollitt, 2004). Many researchers and policy makers are studying the effects of the Chilean privatization because the country accumulated a lot of experience.

Power generation in Chile is organized by four grid systems: SING, SIC, AYSÉN and MAGALLANES. SING, the northern grid, accounts for 26% of national generation and 6.21% of population coverage. SIC, the central region's grid, accounts for 73% of national generation and 92% of population coverage. AYSÉN and MAGALLANES, southern region's grids, cover 0.6% of generation and 1.54% of the population. Gas (2,111 MW of capacity) is the main source of generation resource in the SING area while hydro-power is the biggest power source (5,322.9 MW of capacity) followed by gas generation (2,732 MW of capacity) in the SIC area (see [Figure 4]) (CDEC-SIC, 2011).

[Figure 4] Power system installation (MW) in Chile as of December 31, 2009

System	Thermal				Hydro		Wind-Power
	Coal	Oil	Gas	Others	Run of the River	Dam	
SING	1,215	358	2,117	0	12	0	0
SIC	1,071	2,089	2,733	105	1597	3,725	82
AYSÉN	0	20	0	0	6	11	2
MAGALLANES	0	14	84	0	0	0	0
Total	2,287	2,482	4,929	105	1,617	3,736	84

Source: CDEC-SIC, 2011

The background of Chilean electricity reform was laid when General Pinochet seized the government power by a military coup in 1973. The military government pursued neo-liberal ideas inspired by Chicago economists while mercilessly suppressing democratic movements. Many public companies, which had been nationalized by the former regime, were returned to their previous owners under the Pinochet regime. Large state owned companies, including electricity companies, were forced to trade on a commercial basis (Pollitt, 2004).

The General Law of Electric Services, which was enacted in 1982 and is still in place, laid the foundation of privately owned electricity service providers. The law considered power generation as a competitive business while regarding network service as a natural monopoly. Transmission service is supposed to allow non-discriminatory access, so that all generators can compete in the wholesale market. The law created an independent system operator to coordinate the competitive generators in an open transmission network. The law established two types of customers: regulated and free customers. Free customers, whose maximum demand exceed 2MW, purchase electricity directly from generators with negotiated prices. On the other hand, regulated customers, whose maximum demand does not exceed 2MW, must purchase electricity from local distribution companies and pay prices set by the government (Raineri, 2006)[4].

The privatization started by dividing vertically integrated state-owned utilities into several generation, transmission and distribution companies. Endesa, a state-owned company, was divided into 6 generation companies, 6 distribution companies and 2 small isolated companies. Chilectra, which controlled distribution in Santiago, was split into a

[4] In 2009, sales at regulated prices were 56% (29,756 GWh) and sales at de-regulated price were 44% (23,631 GWh) of total sales.

generation company (Gener) and two distribution companies (including Chilmetro). Endesa, Gener and Chilmetro were sold to private parties between 1985 and 1989 (Pollitt, 2004).

Even though almost thirty years have passed, numerous positive and negative points of views regarding the effect of the privatization exist. Some researchers argue that it was successful because of more efficient operations, better quality of services and more local electrifications. For example, competitive power-generation market attracted numerous domestic and foreign investments in the Chilean electricity industry. Shareholder-controlled generation companies grew from 11 in 1996 to 26 in 2000 (Center for Energy Economics, 2000). The new entries dramatically increased the generation capacity in Chile. The generation capacity in SIC grid grew from 2,713 MW in 1982 to 6991 MW in 2004 and that of SING grid grew from 428 in 1982 to 3,636 in 2004 (Pollitt, 2004). However, it is not clear whether the improvement was because of utility privatization or other factors, such as fast economic growth.

It is also unclear whether Chile's volatile electricity prices are because of competitive markets or not. The SIC area, where hydropower is the main source of electricity, experienced high electricity prices when there were droughts after the privatization. The SING area, where natural gas is the main source of generation fuels, has experienced high prices since Argentina reduced its gas exports to Chile in the 2000s. These problems are related to external problems rather than the endogenous problems of electricity privatization.

3.2. United Kingdom

According to a UK economist, Steven Thomas, the reason for the UK's electricity privatization was not apparent. The UK's electricity service quality was satisfactory, the price was not too expensive and the investments were financed without significant problems. He argues that there were three reasons. First the UK government could generate £5 billion per year income tax and £15 billion for privatization. The other reasons, he argues, were widening the share of ownership for the electric utilities and breaking the political power of trade unions (Thomas, 2005).

The state-owned Central Electricity Generating Board (CEGB) monopolized the English and Welsh electricity generation and transmission from 1957 to the early 1990s. Distribution and retail services were provided by twelve regional electricity boards. The privatization started from dividing a big state-owned electric utility into several small companies and selling the small companies to private parties. The Electricity Act of 1989 stipulated that CEGB should be divided into National Grid and three generation companies: National Power, PowerGen and later Nuclear Electric. National Grid assumed ownership and control of the transmission system and two pumped hydro-power plants, which were subsequently sold off. Currently, National Grid is England and Wales' transmission service provider, which physically builds and operates transmission lines. These four new state-owned companies were privatized after the division (Newberry & Pollitt, 1997).

Currently, the generation market is quite competitive because of many small generators. In 1990, three generation companies supplied 100% of electricity. However, these three companies, or their successors, supplied merely 37.6% of electricity in 2004 (see [Figure 5]).

[Figure 5] Power generators in England and Wales

1990	*(Capacity GW)*	*2004*	*(Capacity GW)*
National Power	*30*	*British Energy*	*9.6*
Power Gen	*20*	*Ingony*	*8.0*
Nuclear Electric	*8*	*PowerGen*	*8.3*
		Scotish and Southern	*5.3*
		Scotish Power	*4.7*
		EDF	*4.7*
		BNFL	*2.7*
		Centrica	*2.2*
		Others	*9.2*
		Plants Reprocessed by Banks, etc	*7.9*
		Plants for sale	*6.3*
		Total	*68.9*

Source: Thomas, 2005

Twelve Regional Electricity Boards supplied retail and distribution services for their regions before the 1990s. Retail competition, in which customers can buy their electric power directly from generators, started with the 1989 Electricity Act. Retail competition was allowed only for customers with more than 1 MW demand initially. This condition increased for customers with above 100 KW demand in 1994. Finally, the limitation was abolished in 1998 and every retail customer could choose his/her retailer (Newberry & Pollitt, 1997).

Today, the former state-owned regional companies supplies 11.9 million customers (46%) while independent companies supplies 15 million customers (54%). However, there are big differences among regions; 83% of electricity in South-Wales is offered by the former public companies while merely 30% of electricity in North-Eastern region is offered by independent companies (UK Department of Energy & Climate Change, 2010).

There is no consensus about whether the privatization in Britain reduced prices or not. Some researchers argue that the competitive market caused a sharp decrease in retail

prices. The prices in London, which is a competitive electricity market, decreased more than that of Edinburgh, which is a traditional regulated market. The domestic electricity price in London was 11 pence per kilowatt hour while that of Edinburgh was 10 in 1990. However, the price in London was 7 pence per kilowatt hour while that of Edinburgh was 8 in 2004 (Dubash & Singh, 2006).

On the other hand, there are critiques that privatization did not decrease prices because of two reasons. Stephen Thomas (2005) argues that the electricity competition did not offer benefits to small consumers. Although cost reductions of one or two percents for large consumers are worthwhile, small percent savings for small consumers are negligible. The other claim is that retailers allocate cheaply purchased electricity to large consumers and expensively purchased electricity to small consumers, who can not choose their electricity suppliers. This phenomenon happens more frequently when small consumers are more captive and large consumers are not. According to Power UK, wholesale electricity price went down 35 percent from 1999 to 2002 and retail prices for the large consumers went down 22 percent. However, the price for small consumers went down merely 5 percent (Thomas, 2005).

3.3. United States of America

3.3.1. The history of regulation

The US government's electricity regulation was focused on regional monopolies before 1992. Some states, including New York, California and Massachusetts, introduced wholesale and retail competition after the federal government enacted the Energy Policy

Act in 1992. However, most states are no longer interested in competitive electricity market after the 2001/2001 Western Energy Crisis.

The federal government introduced the first federal level of electricity regulation by enacting Public Utility Holding Company Act in 1935 (PUHCA). Before PUHCA, privately owned electric utilities provided most of the US electricity; they provided 94 percent of total generation and 16 largest electric power conglomerates controlled three quarters of total generation. The unregulated electric power conglomerates created problems such as abusing market power to increase electricity prices, which eventually increased their revenues. The bigger problem of the electric power conglomerates was the weak ownership structures; one holding company acquired numerous subsidiaries to broaden their influence. This weak structure proved problematic in the 1930s when stock prices plummeted. A problem of a subsidiary could spread to the entire conglomerates, which caused the conglomerate to collapse (Energy Information Administration (EIA), 2000).

The first regulation by PUHCA was that electric utilities had to operate on a vertically integrated basis within contiguous states. The utilities could not diversify into non-utility businesses and the non-utilities could not enter the electricity generation market. For decades, from the 1930s to the 1990s, utilities could supply cheap electricity with decreasing prices. Economies of scale were achieved through new generation capacity investment, technological advances, and declining costs (EIA, 2000).

A number of national movements have stimulated a more competitive electricity market after the oil sanctions in the 1970s. The Public Utility Regulatory Policies Act of 1978 (PURPA), whose original goal was to increase renewable energies, prompted

competitive wholesale electricity markets. Before PURPA, only utilities could own and operate electric power plants; PURPA stipulated that utilities shall buy power from non-utilities, most of which were renewable energy producers (EIA, 2000).

The Energy Policy Act of 1992 (EPA) advanced competition in generation by allowing Independent Power Producers and by ensuring transmission access for independent power producers. Independent Power Producers are generation companies that generate and sell electricity in the wholesale market. The Federal Energy Regulatory Commission (FERC) order 888 and 889 has significantly changed the transmission services from monopoly to competition. The FERC order 888 of 1996 established the principle that all public utilities have to allow generators to use their transmissions with non-discriminatory tariffs and not-discriminatory terms and conditions. The FERC order 889 of 1997stipulated the rules regarding transmission information networks and standards of conduct to guarantee the non-discriminatory open transmission (Joskow, 2003).

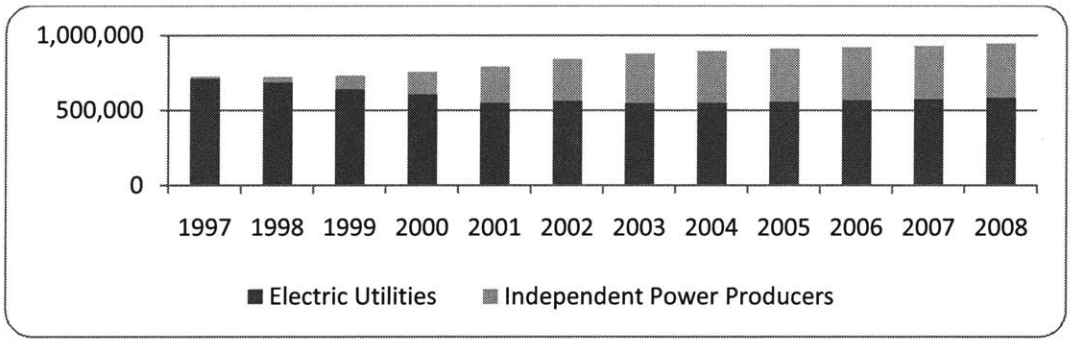
Electric utilities were required to implement generation restructuring by selling their generation capacity to other companies or by separating their generation department from non-competitive businesses such as transmission and distribution. Sixty-three percent of utilities followed the first way and 37% of utilities followed the second from 1998 to 2002. Massachusetts, New York and California were the first few states that implemented competition programs. These states required their utilities to divest substantial amount of their generating capacity through an auction process. Other states, such as Pennsylvania, Maryland and Texas, required the utilities to establish unregulated wholesale power affiliates within a holding company structure. However, generation restructuring has been

halted because no additional states introduced competition after the Western Energy Crisis in 2000 and 2001 (Joskow, 2003).

3.3.2. Competition in generation service

In the United States, Independent Power Producers grew fast in the 1990s and the early 2000s. Their net summer capacity was 25 percent of the total capacity of the US in 2003 while that of 1997 was merely two percent (see [figure 6]).

[Figure 6] Existing net summer capacity by producer type in the US (MW)



Data: from EIA (http://www.eia.doe.gov/cneaf/electricity/epm/table1_6_a.html)

Even though 36% of total US electricity is generated by independent power producers in 2008, there are substantial differences among states. North-Eastern states, such as New York, Pennsylvania and Massachusetts, have higher percentage of electricity generation by Independent Power Producers. However, the wholesale electricity markets of many other states, including Tennessee, Nebraska and South Carolina, are dominated by traditional utilities (see [Exhibit 2]).

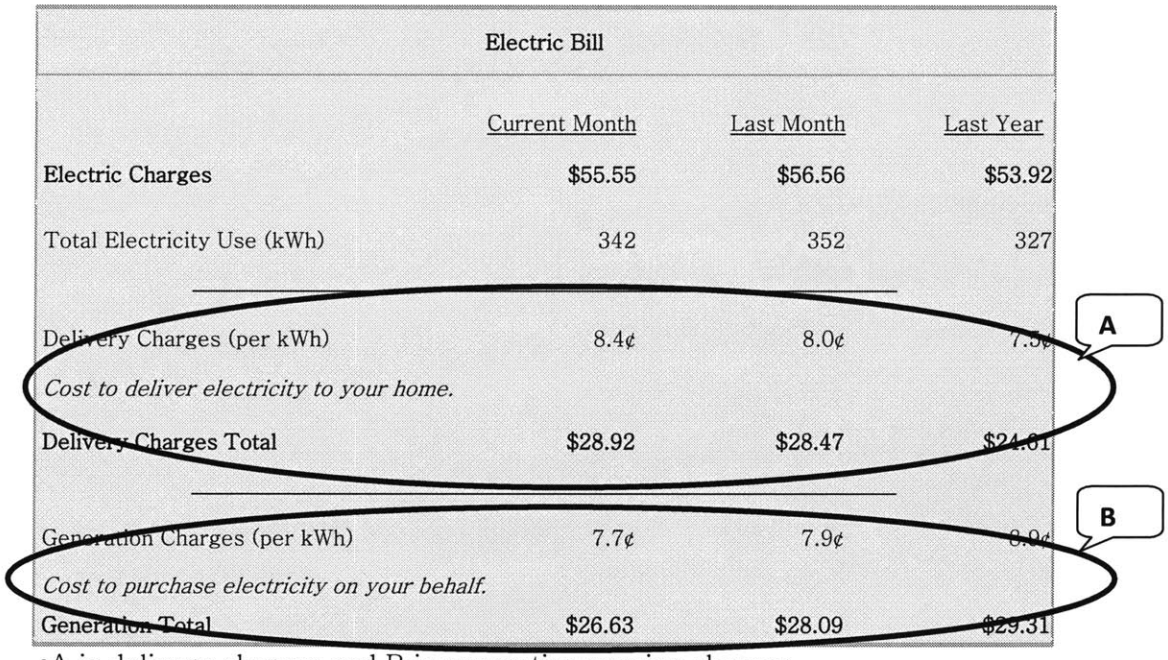
3.3.3. Competition in retail services

By 2008, 16 states, including Massachusetts, New York, Texas, and the District of Columbia, had restructured retail electric service and allowed competitive suppliers to

provide service to some retail customers. These states require the utilities to continue to offer default services to customers, mainly small commercial and residences, who do not want a competitive service. Customers, mainly large commercial and industrial customers, are able to purchase electricity from competitive suppliers other than their traditional electric companies.

Two generation service options are available to consumers. One is Default Service, which is provided by traditional utilities; the other is competitive generation service, which is provided by competitive suppliers. The prices of the competitive services are determined by the competitive market while those of the default service are under state government regulation. Customers pay delivery service charges (A in [Figure 7]) which are monopolized by utilities and generation charges (B in [Figure 7]) which are under competition (competitive service) or traditional regional monopoly (Default Service).

[Figure 7] A sample bill from NSTAR (Jan, 2011)



Electric Bill			
	Current Month	Last Month	Last Year
Electric Charges	$55.55	$56.56	$53.92
Total Electricity Use (kWh)	342	352	327
Delivery Charges (per kWh)	8.4¢	8.0¢	7.5¢
Cost to deliver electricity to your home.			
Delivery Charges Total	$28.92	$28.47	$24.61
Generation Charges (per kWh)	7.7¢	7.9¢	8.0¢
Cost to purchase electricity on your behalf.			
Generation Total	$26.63	$28.09	$29.31

•A is delivery charges and B is generation service charges

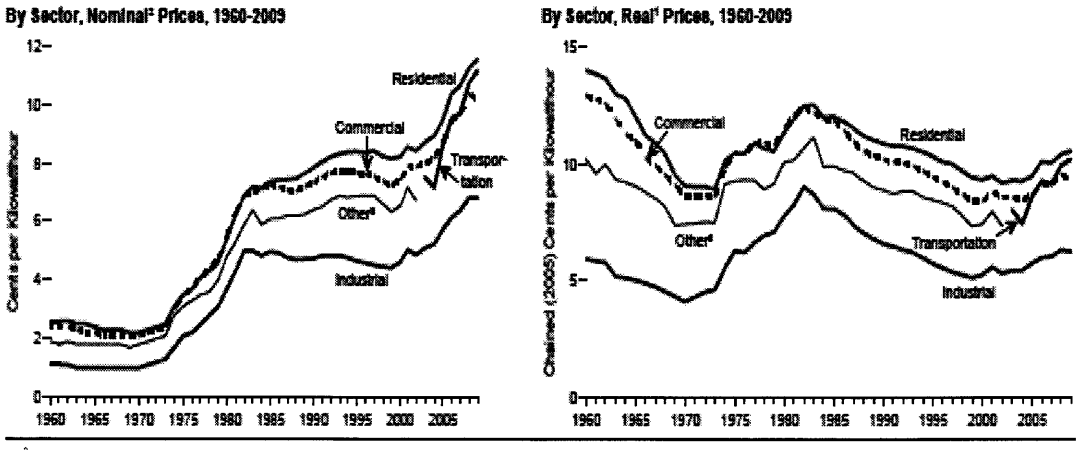
Competitive retail services have been slowly gaining market portion since the de-regulation. Non-competitive generation was dominant in many states in 2000. For example, non-competitive generation supplied electricity to 99.91% residential customers (99.81% of residential consume) and to 86.56% large commercial and industrial customers (77.71% of large commercial and industrial consume) in 2000. However, competitive generation grew fast in many states on several years. For example, competitive generation supplied electricity to 10.63% of residential customers (10.36% of residential consume) and to 74.57% of large commercial and industrial customers (89.90% of large commercial and industrial consume) in Massachusetts in December 2008 (Massachusetts Division of Energy Resources, each year).

3.3.4. The effect of deregulation on price

A number of states, whose electricity prices were higher than others, were the first to introduce retail competition. Other states such as Kentucky and Idaho, whose rates are among the lowest in the country, are not moving as quickly (see [exhibit 2]).

Electricity prices have been fluctuating since 1970. Between 1970 and 1985, national average residential electricity prices more than tripled. Real retail electricity prices began to fall after the mid-1980s until 2000-2001. The prices stayed flat through 2004, but have begun to increase in all regions after 2004 (EIA, 2010) (see [figure 8]).

[Figure 8] US average retail prices of electricity



Source: EIA, 2010, p.260

Some researches argue that the decreasing price trend in the 1980s and the 1990s was because of market competition. For example, the Organization for Economic Co-operation and Development (2005, p.32) said that "In all of the countries that privatized their state-owned electric utility, there is a clear trend showing that electricity prices fell for industrial consumers. In the United States, this downward trend began in the early 1980s, coinciding with the emergence of independent power producers as a first step to introduce market competition." However, MIT economist Paul L. Joskow (2003, p.43) argues that "there is very little information available to evaluate the price effects of retail competition in the US. It would be too hasty to conclude that competition causes market price decrease by using merely time series data." Generally speaking, electricity prices are mainly influenced by fuel, especially gas and oil, prices. Both electricity prices and fuel prices went up in the 1970s and the 2000s while they went down in the 1980s and the 1990s.

To truly understand the effect of competition, difference-in-difference analysis should be applied. If we compare the average retail prices between those states that have

competitive retail markets and those that do not have them, we can see that competitive markets' average retail prices are higher than those of the other states (See [exhibit 4-1]).

When comparing the increasing level of the prices in the 16 states and the other states, the 16 states' increasing level is higher than that of the other states; they grew 50.5% between 2000 and 2010 while the other states grew 33% in the same period (see [exhibit 4-2] to [exhibit 4-6]).

Some might argue that utilities charged more for the less competitive residential service and charged less for the more competitive commercial and industrial services. If they did so, the relative prices of commercial and industrial prices would be lower in the competitive markets. However, the price data implies that there is little possibility of such actions. The relative prices of commercial service between the 16 states and the other states have no specific trend in the last 20 years (see [exhibit 4-7] to [exhibit 4-8]). The relative price of industrial service in the 16 states, which are more competitive services in competitive markets, increased much faster than other states (see [exhibit 4-9] to [exhibit 4-10]). This implies that the competition in the 16 states did not decrease the relative prices of industrial electricity service.

Chapter4: SHOULD KOREA PRIVATIZE KEPCO?

4.1 Cost and benefit method

Whenever a government develops a policy, it measures the expected costs and benefits of the policy. This thesis tries to measure the economic costs and benefits. Because measuring economic effects is easier and more objective than measuring political or social effects, this thesis is going to investigate in only economic matters.

The first benefit and cost from privatization is caused by ownership change from government to private parties. As the public electric utility is one of the biggest companies in Korea, the government could make good revenue from domestic and foreign investors. This thesis also investigates what the government has to give up.

The second benefit is increased investment in electricity, which will eventually lower electricity prices. This thesis will investigate foreign countries that privatized their state-owned electricity, to find out whether their investment increased or not. This paper will also examine how KEPCO attracted investment and anticipate how the newly-privatized electric company will attract investment.

The third issue is whether private ownership or competition caused by privatization will decrease electricity prices. This paper will study the UK, which privatized its state-owned electric utility in the early 1990s and the USA, which introduced competition in its generation and retail markets.

The forth issue is transition cost. This thesis studies the relationship change between government and private industry. Because KEPCO has been an important government policy tool for economic development, its privatization might affect the economic

development of Korea. This paper particularly will focus on the nuclear power industry, which is regarded as one of the most popular economic policies in Korea.

The last issue is transition cost, such as incomplete competition and inadequate coordination. This thesis probes 2000/2001 Western Energy Crisis and the 2003 North-East America blackout. This paper also tries to anticipate whether the two kinds of transition problems can happen in Korea in the process of KEPCO privatization.

4.2 Ownership change

The first and most evident benefit from the sales of KEPCO is government revenue. In other words, the Korean government can make ₩9,469 billion ($8,481 million[5]) if it sells its shares of KEPCO[6]. Nine point five trillion Korean Won is an enormous amount of money on the scale of the South Korean economy, whose GDP was ₩1,063 trillion in 2010. The government might repay 3.05% of the public debt, ₩309 trillion as of December 2010, if it sells all of its KEPCO stock.

When it sold 21% of KEPCO stock in August 1989 and 34% of POSCO shares in April 1988, the Korean government made a great deal of money (Song & Song, 1992). The government made 2.5 times more money by selling its shares in 1989 rather than selling in 1998 because the stock price was 2.5 times higher in 1988 and 1989 than in 1998 (see [Figure 9]).

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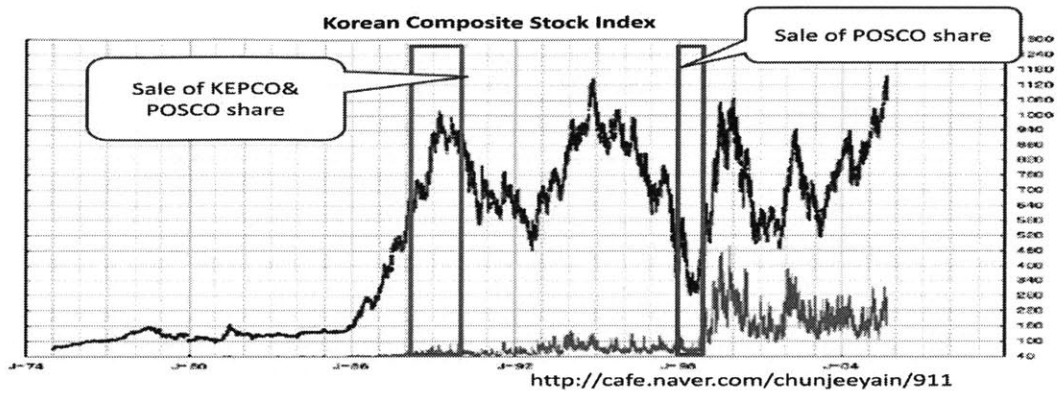
[5] $1 was ₩1,116 in Feb 16, 2011 (source: the Bank of Korea website)

[6] KEPCO's total stock price was ₩18,541 billion and the government owns 51.07% of the share as of Feb 16, 2011 (source : the Korea Stock Exchange website)

[Figure 9] Korean composite stock index from 1980 to 2004

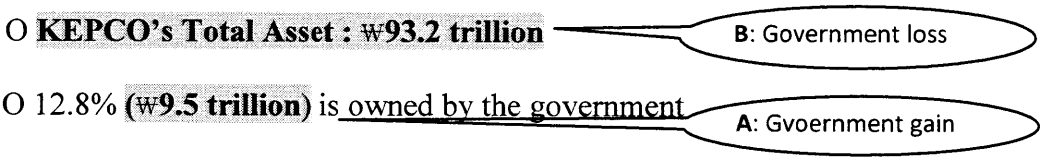


Korea has a successful record of obtaining foreign currencies by selling its most lucrative public companies. After the 1997 foreign exchange crisis, Korea had to privatize 11 public companies, such as POSCO, which is one of the world's biggest steel makers, and KT, which is the biggest domestic telecommunication conglomerate in the country. However, Korea sold its POSCO shares in 1998 and 1999 when the stock price was lower than 10 years had been before and 10 years had been after (Korean government, 1999 and 2000). The bigger problem was that eight percent of POSCO shares were sold in the international stock market in 1999 when the stock was cheap and Korean currency was extremely cheap. The experience of KT stock selling in the world market was better than that of POSCO. KT stock sold for 20% more expensive on NYSE than on the domestic market, and the total price sold on NYSE was $2,485 million (Jin, 2006).

If the Korean government sells its shares of KEPCO, it would have to give up the whole ownership of KEPCO and KEPOC's numerous subsidiaries. The problem is that the government might give up the ₩93.2 trillion worth of public companies while earning merely ₩9.47 trillion. In other words, the government might gain A while losing B (see [figure 10]). This is because of KEPCO's total assets are much bigger than its share values. In sum, KEPCO privatization means the ownership change of all generation, transmission

and distribution lines that Korea has built for more than a century. Furthermore, the government also has to give up its control over the subsidiaries of KEPCO, whose assets are ₩30.3 trillion. The subsidiaries are not only generation companies but also numerous lucrative companies: Korea Hydro & Nuclear Power Co., which has accumulated several decades of Nuclear power plant operation and is making billions of dollars by selling its know-how to foreign countries, and KEPCO International Hong Kong Ltd., which has been investing in the promising Chinese electricity market. (see [Exhibit 1]).

[Figure 10] Government gain and loss from KEPCO sales



One concern is whether the government should sell its KEPCO shares to conglomerates, foreigners, or the general public. The ramifications of new owners on social welfare are another concern of privatization.

The simple way to privatize KEPCO is by selling the government's shares to private companies. However, KEPCO is too big to find a new owner; it is the second biggest company in terms of asset values and twelfth biggest company in terms of market values (see [Exhibit 5]). Selling one of the generation subsidiaries of KEPCO is practically difficult as well. For example, in the early 2000s, the Korean government tried to sell one of the generation subsidiaries but failed. The first reason for the failure is that the divided generation subsidiaries are still too big to find a new owner who has enough financial capability. Each generation subsidiary has approximately ₩2.1 to ₩2.6 trillion assets. Assuming that companies with market values bigger than ₩10 trillion can merge the

KEPCO generation subsidiaries, only 21 companies have the capability. The number decreases to seven assuming that companies that have more than ₩20 trillion of market value can acquire the KEPCO generation subsidiaries. Only seven non-financial companies' market values are more than ₩20 trillion and 21 non-financial companies' values exceed ₩ 10 trillion (see [Exhibit 5]).

Considering the ownership structure of the 21 companies, only eight conglomerates are truly separate companies: Samsung, Hyundai, POSCO, LG, SK, S-Oil, Lotte Shopping and Honam Petrolium. This is because of the "chaebol"[7] ownership structure in Korea; Hyundai chaebol owns Hyundai Motors, Hyundai Mobis and Kia Motors; Samsung chaebol owns Samsung Electronics, Samsung Electro Mechanics, and Samsung Construction & Trading.

In short, if the government insists on domestic buyers, it must sell KEPCO to chaebols. However, it is not an economically good option to increase the chaebols' economic power, which is already very strong.

Another option is that the government sells its KEPCO shares to private individuals. By doing this, the government can prevent a small number of investors from dominating the electricity market. Actually, the Korean government sold some of its shares of KEPCO and POSCO in this way after the inauguration of new president Roh Tae-Woo in 1988 (Song and Song, 1992). President Roh promised to share the ownership of lucrative state-owned companies by selling the government shares to the general public. In 1988, the government sold 31 million POSCO shares to POSCO workers and general public at a price of ₩15 thousand for a share and ₩413 billion total. In 1999, the government also sold

[7] A family-controlled industrial conglomerate in Korea

128 million KEPCO shares to KEPCO workers and the general public at a price of ₩13 thousand for a share and ₩1,272 billion total. The government restricted the sales to low-level workers of the public companies and low-income citizens. The buyers' assets might have more than doubled right after the deal, because the market prices were two or three times higher than the purchase price (compare column A and B in [figure 11]). However, their asset values decreased to the purchase- price level two or three years after the purchase, because the stock prices went down in the early 1990s (compare column C and D in [figure 11]).

[Figure 11] Share prices of POSCO and KEPCO

	Column A	Column B	Column C	Column D
	Purchase Price	Market Price	Highest Price	Lowest Price
POSCO	15,000	41,400 (June, 1988)	41,400 (June, 1988)	17,600 (June, 1991)
KEPCO	13,000	23,000 (Aug., 1989)	26,000 (Aug, 1989)	13,000 (June, 1991)

Source: Song and Song, 1992

Although the sales did not generate the profits the government hoped for, the plan to distribute the ownership of public companies was successful. This is because no one can own more than 3% of shares of "public corporations" under the regulation of the Securities and Exchange Act (Article 200). For example, more than 80% of POSCO shares are owned by numerous, small-scale shareholders so that no one can significantly influence the company's decision making. According to POSCO, 81.16% of its shares are owned by numerous foreigners and personal stake holders, 5.08% by National Pension Service, 5.04%

by Nippon Steel Corporation, 5.97% by financial institutions, 2.85% by a telecommunication company (POSCO, 2010).

4.3 Investment in electricity

Historically, KEPCO has offered stable and cheap electric power by obtaining tremendous foreign investments. Before KEPCO was established in 1961, Korea experienced severe electricity shortages. The total generation capacity was merely 74% of the peak demand at that time (Kang, 2011). After the establishment of KEPCO, the Korean government underwrote KEPCO's numerous loans from foreign countries, especially the United States. For example, KEPCO borrowed $7.5 million from the US at a 0.75 percent annual interest rate to build a transmission and distribution network in 1964 (MOFAT, 1964). KEPCO also borrowed $22.5 million from the US government at a one percent annual interest rate to build 125MW thermal power plant in Seoul in 1966 (MOFAT, 1966). In 1967, KEPCO borrowed $12.7 million for the second Transmission & Distribution Project and $17.5 million for the Yongnam Thermal Power Plant at a one percent annual interest rate. Considering Korea's economy in the 1960s, the $60 million loans given to KEPCO's four projects was two to three percent of Korean GDP[8]. This amount of foreign investment was only possible because the Korean government guaranteed the loans; no private investors at that time would have put such a big money into Korea's poor economy.

However, although foreign aid acted as the seed money for Korean electrification, aid is no longer the advantage of state-owned KEPCO. Currently, Korea is supporting other countries to build electricity infrastructure rather than obtaining aid from foreign

[8] Korea's GDP was $2 billion in 1960 and $3 billion in 1965 (source: Bank of Korea website)

countries. Korea donated or aided at least twenty projects in Laos, Bangladesh, Nicaragua, Jordan and others in 2010. In the same year, Korea gave a $25 million loan to Tanzania to build 132 kV transmission lines and $49 million to Mozambique to extend transmission and distribution lines with a 0.01% interest rate (MOFAT, 2010a).

Some might argue that Korea could rely on international aid on public projects other than electricity infrastructure if Korea privatizes KEPCO. Actually, many developing countries have privatized their public electric utilities to spend foreign aid on many other purposes[9]. In other words, if a country does not spend foreign aid on electricity, it can spend the aid on other purposes such as education or hospitals. Furthermore, if a country privatizes its public electric utility, international financial investors would become more likely to invest in the country's electricity business.

Today, KEPCO obtains capital by issuing bonds in private markets rather than taking foreign aid. Because KEPCO's credit level has always been one of the best in Korea, borrowing money is not a major issue for KEPCO. This company's Moody's and S&P credit ratings have been better than A1 or A$^-$ for most of the last twenty years (see [Exhibit 8). Based on its favorable credit, KEPCO has entered into numerous new businesses. For example, it established KEPCO International Philippines (KEPCO-IP), which borrowed $281 from a Japanese bank. KEPCO supported KEPCO-IP by guaranteeing the implementation of the Philippine project. Another example is KEPCO Shanxi International, which is investing in Chinese electric power generation. KEPCO guaranteed that it will compensate Deutsche Bank's loss invested in the Chinese project if the project is not

[9] Interview with MIT lecturer, Ignacio Perez-Arriaga, March 2011

successful. KEPCO guaranteed the repayment of $180 million loan, which is given to KEPCO Shanxi International Ltd by HSBC and a Korean bank (KEPCO, 2010).

If KEPCO is privatized as one entity, its credibility and good reputation will probably stay the same. However, if KEPCO were divided into several small companies, its ability to attract large financial investments might decline. In other words, a $281 million or a $180 million loan guarantee is not a big problem for KEPCO, whose assets are $83.52 billion. However, few financial institutes will invest in an energy venture company that is not supported by a holding company like KEPCO.

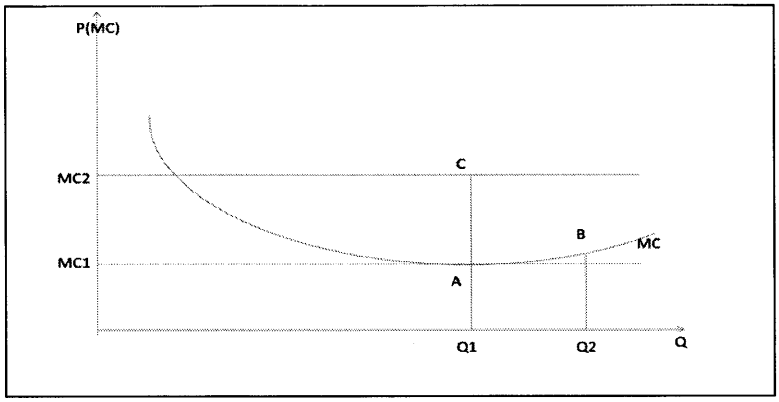
In conclusion, there is little possibility that a privatized KEPCO would attract more financial investment. The possibility might decrease if KEPCO is divided and sold as several small companies. New investors would be interested in investing in the Korean electricity market if they can make profit. However, because the government will still exert a great deal of control over pricing, high profit is not necessarily assured.

4.4 Electricity price

Some studies, especially those that focus on the UK, argue that electric utility privatization followed by competition decreases electricity prices (Boardman & Vining, 1989; Green, 1999; Newbery & Pollitt, 1997). They argue that state-owned electric utilities monopolizing electricity markets are less efficient than competitive electricity suppliers. In other words, their idea is that state-owned electric utilities produce more electricity than the socially appropriate level (Q2 rather than Q1 in [Figure 12]). They also argue that publicly-owned companies are managed less efficiently than private companies because they do not need to compete in the market or they have more information about their

operation than regulators (MC2 rather than MC1 in [Figure 12]).

[Figure 12] Prices and quantities of electricity service



For example, electricity prices in England and Wales decreased after 1990 when the UK privatized its state-owned electric utility: CEGB. David Newbery (1997) argues that the price decrease is mainly due to "dash for gas," which privatized generation companies shut down coal-power plants and invested in gas-power plants. He states that while 74 million tons of coal (92% of generation fuel) was burnt for generation in 1990, 30 million tons of coal was used five years after the privatization. He adds that coal prices for generation felt 20% in the same time.

Another reason for decrease in electricity price is cost reduction; privatized companies operate more efficiently than publicly-owned electric utilities. While there is no strong relationship between electricity privatization and electricity price decrease, private electric companies are slightly more efficient than public firms. Michael Pollitt (1995) found that private firms are 2% more efficient than public firms by comparing 768 power stations in the world. In the US, investor-owned utilities are more cost-effective in electricity generation while publicly-owned electricity companies are more efficient in electricity distribution (Kwoka, 2005). As generation cost is around 60% of total electricity

price while distribution cost is less than 10% of total price, productive generations reduce more cost than distributions.

Two issues are related to price decrease: costs are unevenly distributed to the general public and benefits are concentrated on the new owners of the newly-privatized electric companies. Although privatized companies are more efficient than publicly-owned companies, the cost of efficiency is usually the layoffs of low-wage and less-skilled workers. For example, the number of coal workers in the UK decreased from 25,000 in 1985 to 7,000 in 1994, when the "dash for gas" occurred in the 1990s (UK, Department of Trade and Industry, 1995). This thesis does not investigate the effect of downsizing on less-skilled workers because it is a political or social matter rather than an economic issue.

Another issue of privatization is that the benefits are concentrated on the new owners of electric companies. In other words, the new owner can obtain more benefits from reducing costs and maintaining the prices. As the newly-privatized companies' profits increased after the privatization in the 1990s, the companies' share prices went up more than 250% (Newbery & Pollitt, 1997). Although new investments in electricity generation followed the sharp increase in the share prices, market price of electricity did not decline rapidly. The profits might be allocated to shareholders rather than lowering electricity prices.

The last issue is that large consumers benefit more from reduced prices than do small consumers. As mentioned in Chapter 3.3, some privatized electric companies charge small consumers more while charging large consumers less. Electricity retailers allocate cheaply-purchased electricity to large consumers and expensively-purchased electricity to small consumers, who are reluctant to change their suppliers because it takes time and

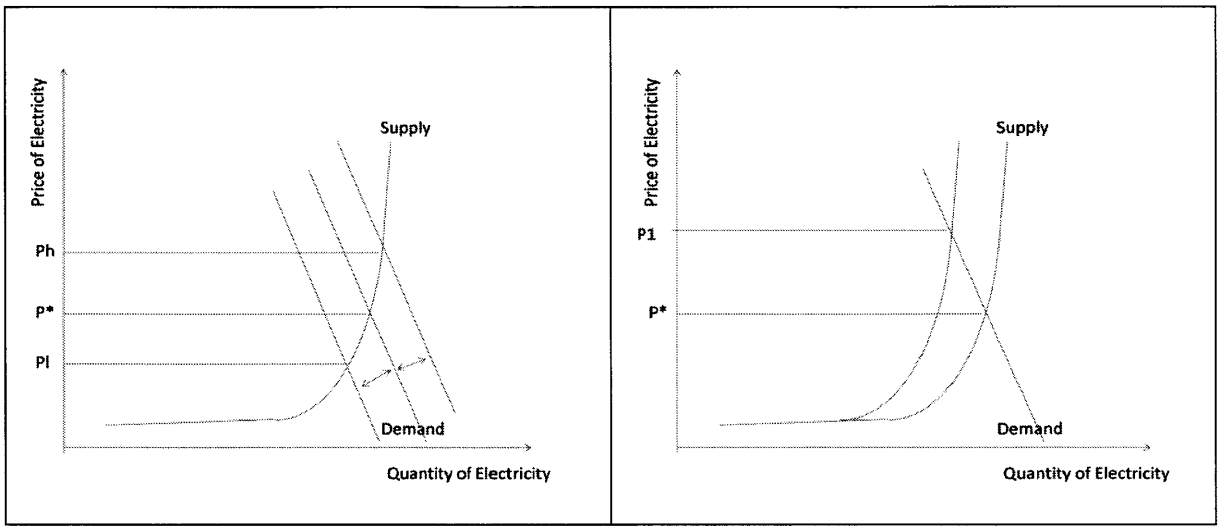
information. Retail prices for large consumers went down 22 percent from 1999 to 2002 while prices for small consumers went down a mere 5 percent (Thomas, 2005).

Some studies argue that state-owned electric utilities, which monopolize market, offer cheaper electricity than privately owned energy suppliers, which compete against other suppliers. As mentioned in Chapter 3.5, the prices in the traditional market are lower than the deregulated market. Furthermore, the increasing rate of prices is lower in traditional markets than de-regulated markets (see Exhibit [4-1] to [4-9]). Some researches mention that government regulation on retail prices, rather than competition, prevented prices from increasing. While large consumers have more incentives for changing their electricity suppliers and many did so, little evidence support the idea that prices for large consumers decreased after the deregulation in the US (Apt, 2005).

While electricity prices in a competitive market are not less expensive, they are more volatile than in a non-privatized, traditional market. As electricity can not be stored, its price must be decided by supply and demand every half hour or every hour. The problem is that both supply (marginal cost) and demand are inelastic to price changes (Sweeney, 2008). This problem causes sharp price-change whenever demand changes across every hour, day and season. Prices change when demands change and supplies change (see [Figure 13]). As shown in the [Exhibit 10], electricity demand is high during the day while low at night; high on weekdays while low on the weekend; high in summer and winter while low in spring and fall. This means that electricity generation companies have to burn expensive fuels such as gas and oil to meet peak demand on summer weekdays. On a spring weekend night, however, generation companies can supply electricity at virtually no cost because base-loads, such as coal and nuclear power plant, generate enough electricity

and their marginal cost is near zero.

[Figure 13] Electricity demands and supplies



Considering the fact that fuel prices mostly affect generation prices, privatizing KEPCO may not decrease the price significantly. KEPCO is offering one of the cheapest electricity prices while purchasing one of the most expensive fuels in the world (see [exhibit 11]). On the other hand, Korea's ratio of distribution losses to generation was the smallest in the world recording 3.85%[10] in 2008. These two data point that KEPCO is efficiently running its generators and networks.

KECPO's activities, such as generation, transmission, distribution and retail services, have different effects on prices because each activity has a different character. Regulators can divide generation and retail services into several small units and introduce competition among the small companies in each market. However, regulators can not divide transmission and distribution because they are national and regional networks which

[10] Divide distribution loss column by total generation column in [Exhibit 11]

connect all generators and consumers. All small countries allow only one entity to monopolize transmission nationally and distribution regionally; large countries divide transmission and distribution into regions and franchise monopoly in the regions. For example, traditional utilities, such as NSTAR and National Grid, own and operate some part of Boston area transmission and distribution lines. On the other hand, a non-profit organization, Integrated System Operator – New England (ISO-NE) coordinates the network in New England. In sum, the government can divide generation parts of KEPCO into several small generation companies and introduce competition among the divided companies while just privatizing transmission and distribution.

Korea has long been interested in privatizing generation because generation cost is around 65% of total electricity prices (Kim, 2010). The Korean government separated the generation parts form KEPCO and established six generation companies: five regional generators and one nuclear/hydro power generating company. However, these companies are not competing in the market but selling electricity with their marginal generation costs, which are set by a government agency, KPX.

If KEPCO is privatized, the newly-privatized company will increase electricity prices because current prices are lower than actual costs. According to the Korean government, electricity price was 93.7% of the cost in 2010 after the government raised the price, which was 91.5% of the cost in 2009 (MKE, 2010e). Because of political concerns, such as protecting low-income citizens and considering economic downturn, the government has suppressed electricity prices when the economy is in recession. KEPCO balances its profits and losses in the long term rather than the short term. In other words, KEPCO made a net profit for the five years of 2006 to 2010 while making not losses for

three years of 2008 to 2010 (see [Figure 14]). The government might raise the electricity price to compensate KEPCO's three year loss if the world economy overcomes the current recession. However, if KEPCO becomes privately owned, it will probably have to frequently raise prices to make profit and pay dividends to shareholders. No shareholders will wait several years until the newly-privatized company makes a profit.

[Figure 14] Annual sales and net profits of KEPCO

Unit: ₩ billion

Year	2006	2007	2008	2009	2010
Annual sales	26,979.0	28,983.8	31,522.3	33,685.7	39,189.6
Net profit	2,070.5	1,556.8	-2,952.4	-77.7	-61.4

Source: http://dart.fss.or.kr/

4.5 Reduce government influence on economic development

Korea offered numerous favorable conditions to few industries. Discriminatory electricity tariffs, low interest rates, cheap labor costs and tax breaks were the favorable conditions. This legacy still remains in the electricity tariff in Korea. The Korean government employed KEPCO as an important instrument of discriminatory electricity pricing. The publicly owned electric utility has offered cheap and high-quality electricity to nationally important industries, such as heavy and petro-chemical industries in the 1980s. Today, Korea has different electricity-price tables for educational, street-lights and agricultural services as well as residential, commercial and industrial services. Knowledge-service industries, including nanotechnology labs, venture companies and integrated telecommunication facilities, can use cheap electricity (KEPCO provision Article 59).

The government can offer favorable prices for nationally important electricity demand both before and after privatizing KEPCO. The government can regulate the

privatized company to offer cheap electricity to any industries they want to support. The government can also give tax credits for specific industries so that the newly-privatized company will offer discounted prices for the industries. The only aspect the government has to consider is whether the favorable conditions for specific industries increase social welfare or not. While there are many debates whether a government should support specific industry or not, the government can implement such policies no matter whether it privatizes KEPCO.

Another concern about privatization is that the Korean government, which is popular for its deep involvement in economic development, has to give up its policy tool: KEPCO. The nuclear power industry in Korea is a good example of this. The Korean government has long supported nuclear power industries with KEPCO by building numerous nuclear plants, supporting research and development, encouraging exports and developing regulations.

Korea's nuclear power industry has evolved from import to import-substitution and to export orientation. Its nuclear power plant history has four eras (see [Exhibit 4]). The first era, from the late 1960s to the late 1970s, is when KEPCO merely bought foreign nuclear plants without any knowledge about the industry. The second era, from the late 1970s to the mid 1980s, is when KEPCO understood the whole picture and tried to develop domestic technologies. The third era, the 1990s, is when Korea developed 95% of domestic technologies. The fourth era, after the 2000s, is when Korea developed its own nuclear power plants (MKE, 2011b).

The three first-era power plants were built by foreign technologies in the 1970 and the early 1980s. As Korea did not have any knowledge about nuclear power plants, it

depended on foreign countries for designing, purchasing materials, constructing, test-running and follow-up services. Korean companies, such as Hyundai and Donga, did the simplest jobs such as constructing building sites, and supplying law materials and labor under the supervision of foreign companies. KEPCO financially supported the construction with foreign aid, which is guaranteed by the Korean government (MKE, 2011b).

The second era is when KEPCO tried to develop domestic technologies. After vaguely understanding nuclear power plant construction, KEPCO changed its contract from turnkey to non-turnkey in the mid 1980s. Non-turnkey contracting is separately contracting each part of construction under KEPCO's supervision. By dividing nuclear power plant construction into numerous steps, KEPCO could find which parts could be domestically produced and which technology should be developed (Amsden, 1989). Six power plants-- Kori #3, Kori #4, Youngkwang #1, Youngkwang #2, Wlojin #1, and Woljin #2-- were built under the non-turnkey scheme in the 1980s. Korean companies took part in all the steps, including designing the plants, supplying machines and constructing the plants. Korean companies accumulated knowledge about building construction, while understanding five percent of designing know-how and forty percent of machine-related technologies (MKE, 2011b).

The third era is when KEPCO and domestic companies developed enough technologies and accumulated plenty of experiences. After Korea obtained experiences and technologies, KEPCO contracted mainly with Korean companies and mandated the companies to build power plants with their own technologies with few exceptions. Foreign companies had to sub-contract with the Korean companies, not with KEPCO anymore. Youngkwang #3, which was completed in 1994, and Youngkwang #4, completed in 1996,

are examples of the new trend.

Wolsung #2, Wolsung #3, and Wolsung #4, which were completed from 1997 to 1999, are other examples of domestic technology developments. KEPCO contracted with a Canadian company, AECL, for designing and equipment supplies. At the same time, KEPCO made a technology transfer contract with the Canadian company to obtain heavy-water reactor technology (MKE, 2011b).

The fourth era is when Korea developed its authentic technologies. KEPCO has been constructing the Korea Standard Nuclear Power Plants (OPR1000) since the mid 1990s. KEPCO developed OPR1000 design and applied this design on six projects: Woljin #1, Woljin #2, Woljin #3, Woljin #4, Youngkwang #5, and Youngkwang #6. KEPCO is also constructing four other OPR1000 power plants: Sin-gori #1, Sin-gori #2, Sin-wolsung #1, and Sin-wolsung #2. There is no doubt that Korean nuclear companies and KEPCO accumulated knowledge by continuously constructing nuclear plants. Currently, KEPCO is building Advanced Korea Standard Nuclear Power Plants (APR1400), including Sin-gori #3 and Sin-gori #4. KEPCO consortium signed a contract with United Arab Emirates to build four APR1400 nuclear power plants and to supply all related services, such as maintenance and nuclear fuel, for a cost of $40 billion in 2009 (MKE, 2009).

Government-lead research and development made the import substitution possible. In 1983, the government developed a master plan to localize most of the nuclear power plant technologies and to develop OPR1000. The plan set a goal of "developing 95% domestic technology," and distributed assignments to public and private companies. Under the plan, KEPCO had to develop general project management; KEPCO E&C was in charge of plant design; Doosan Heavy was in charge of machines; and construction companies

were in charge of building construction. As a result of the plan, Korea's domestic technologies for nuclear power plant increased from 60% in 1986 to 95% in 1995. After developing OPR1000, KEPCO developed a more advanced nuclear power plant model, APR1400, from 1992 to 2002. Based on the OPR1000 technology and the experiences of building ten OPR1000, the new model reflects Korea's numerous experiences and self-developed technologies. According to the Korean government, its nuclear power plants are some of the safest, least expensive and quickest to build (MKE, 2009).

If KEPCO were a private company, the nuclear industry could not have grown so fast in Korea. Private electric utilities merely buy the cheapest power plants, no matter which type it is. In other words, all nuclear power related companies and technicians would have to rely on the newly-privatized electric utility, which does not care about them. In this case, the nuclear power companies and technicians have no choice but to export their products and services to foreign countries. However, Korea's nuclear industry is not as competitive as foreign ones yet. Furthermore, KEPCO's nuclear power business might be vulnerable to international business cycles as they do not have any steady demands.

The US and French nuclear power industries are good examples of different electric utility ownerships which affect different nuclear power plant installation. The French nuclear industry is more developed than that of the US because the French government has more influence on the industry than the US government.

The US utilities did not build any nuclear power plant after the Three-Mile Island accident in Pennsylvania in 1979, although they built 104 nuclear plants in the 1960s and the 1970s (Delmas & Heiman, 2001). Private companies have avoided investing in nuclear powers because of the enormous construction cost and long construction period that is

frequently prolonged by public opposition. The capital costs increase dramatically when the construction periods are extended, so that electricity from nuclear plants gets more expensive relative to that from other sources such as coal. Ordinarily, the production cost from a nuclear plant is 21.16 $/MW, while that of a coal plant is 35.69$/MW in 2008 (US, Nuclear Regulatory Commission, 2010). The private companies' negative attitudes toward nuclear power plants are different from the government's attitude. For example, President George W. Bush said "America should also expand a clean and unlimited source of energy, nuclear power" when he announced his energy plan in 2001. Vice President Dick Cheney added that "the government has not granted a single new nuclear power permit in more than 20 years. But there is a reason for that; no utility company has submitted an application for a nuclear power permit in more than 20 years (The New York Times, 2001)." In sum, the government has not effectively managed private companies to follow its guidance.

On the other hand, the French government is popular for nuclear power promotion policy with its state owned utility, Électricité de France (EDF), and publicly owned multi-national nuclear power conglomerate, Areva. The French government has promoted nuclear power industry since the early 1960s because it believed nuclear power enhances France's energy independence from foreign states. The French nuclear industry is distinguished by few players and strong government leadership. In 1955, the French government banded several government organizations to promote nuclear power industry: EDF, Commissariat al 'Energie Atomique (CEA), Cogema and Framatome. EDF controlled all electricity services including generation, transmission and retail services. CEA administered researches, and controlled all nuclear activities such as developing

nuclear power applications. The French government also owned both Cogema, which had a monopoly on nuclear-fuel processing, and Framatome, which produced nuclear reactors. In 2001, the French government established a government-owned nuclear conglomerate Areva by merging CEA, Cogema and Framatome (Fagnani & Moatti, 2004). Currently, Areva supplies all nuclear power services including "uranium exploration, mining and concentration; uranium conversion and enrichment; nuclear fuel design and fabrication; design and construction of nuclear reactors; supply of products and services for nuclear power plant maintenance, upgrades and operations; treatment and recycling of used nuclear fuel; and cleanup of nuclear facilities" (Areva, 2009).

It is too hasty to conclude that Korea should keep the ownership of KEPCO to raise the company's competitiveness with the US and French examples. However, it is true that KEPCO has grown up to an international electricity conglomerate with the support of the government. It is also true that KEPCO is still too small to compete against multi-national companies such as Areva, which is owned by the French government.

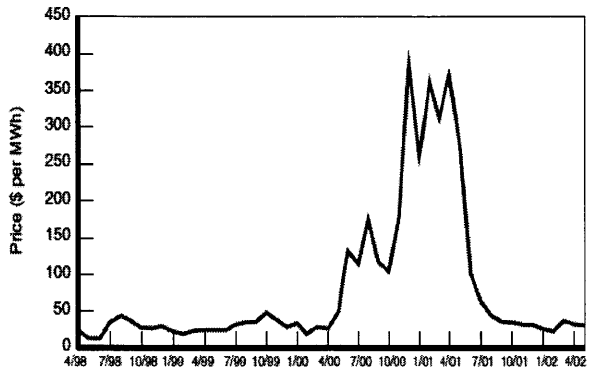
4.6. Transition cost

Even though the benefit from the privatization is bigger than the cost, the government has to consider the transition cost. Although perfect competition can finally be achieved by privatization, developing such a condition is not always quick and easy.

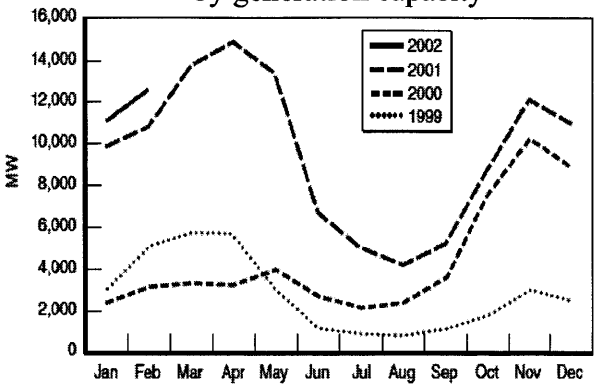
Imperfect competition can dominate the electricity market if a few companies explicitly or implicitly collude while the government does not know the situation. The 2000/2001 Western Energy Crisis is a good example of wholesale market manipulation by few generation companies. In 1998, California introduced a competitive wholesale

electricity market according to the California Assembly Bill 1890. Electricity prices were stable right after the de-regulation until the spring of 2000 (Weare, 2003). However, prices increased rapidly after April 2000 and remained extremely high until July 2001 (see [Figure 15]). California electricity consumers spent $40 billion in debt cost because the wholesale prices were three times more expensive in 2000 and 2001 than 1999; the electricity price per year was $27 billion dollars in 2000 and 2001 while that was $7.4 billion in 1999 (Weare, 2003). The high wholesale electricity prices provoked severe problems to customers and electric utilities: San Diego Gas & Electric (SDG&E), Pacific Gas & Electric (PG&E) and Southern California Edison (SCE). SDG&E customers had to pay two or three times more expensive prices because their electricity prices were based on wholesale prices. On the other hand, PG&E and SCE customers were protected from the soaring wholesale prices because their electricity bills were fixed by the government. PG&E and SCE had to offer electricity with pre-determined prices while being compensated for their previous investment in generations; SDG&E had to offer electricity based on wholesale market price because its compensation period ended in July 1999. The utilities sold electricity at a price of $65 per megawatts-hour ($65/MWh) to their customers when the wholesale prices were ranging from $150/MWh to $1000/MWh (Sweeney, 2008). As PG&E and SCE had to buy expensive electricity in the wholesale market and sell cheap electricity in the retail market, their financial statuses were dangerous; PG&E went bankrupt in April 2001 and SCE was almost bankrupt until renegotiating a new tariff with the regulator (Weare, 2003).

[Figure 15] California electricity wholesale Price



[Figure 16] Scheduled generation offline by generation capacity



Source: Weare, 2003

Uncertainty about deregulation, incomplete market design and market manipulation are the main reasons of the energy crisis. The uncertainty about transitioning from a regional monopoly to a competitive wholesale market led to insufficient investment in power generation. While electricity demand grew 1.5% in the 1990s and 4% between 1998 and 2000, generation capacity did not grow at all in the same time. Investors had less interest in power plants when electricity prices were cheap before the energy crisis; they increased the investment when they saw high electricity prices (Sweeney, 2008).

Incomplete market design, which regulated utilities to buy all electricity in the spot-wholesale market, was proved problematic when wholesale prices were extremely high. Both utilities and final customers such as households and factories suffered from the 100% spot-wholesale market regulation. If utilities raise retail prices when wholesale prices increase, final customers paid more electricity charges. If utilities do not raise retail prices when wholesale prices increase, they confront severe financial problems.

Market manipulation by significant generators is one of the most debated reasons of

the crisis. The General Accounting Office (GAO) proved that the wholesale electricity market in California from August to October 2000 was manipulated (GAO, 2001). While 1998 prices were high in the afternoon when the demands were high, the 2000 prices were higher in the morning than in the afternoon. Other research raised the possibility that generation companies intentionally shut down power plants (Weare, 2003). This research found that 2000 and 2001 scheduled generation off-line was enormously higher than 1999 (see [Figure 16]).

Many studies argue that the British and Wales electricity wholesale market was also manipulated. While marginal costs are equal to market prices in competitive markets, the British and Welsh market prices were higher than marginal costs (Wolfram, 1998; Green, 1999). However, Catherine D. Wolfram found that the market prices were slightly higher than the marginal cost. This means that market manipulation was not implemented thoroughly because of threat of government intervention, possibility of new entrants and "contract for differences (CfD)" (Wolfram, 1998). Under CfD, electricity buyers and sellers compensate other parties when market prices are higher or lower than their contracts. For example, generators financially compensate for their consumers' loss if market prices are higher than the contract prices. As the two major British and Welch power generators, PowerGen and National Power, sell more than 80% of their electricity by CfD, they have little incentive to manipulate market prices (Green, 1999).

Deficient transmission lines and poor coordination are also problems of the transition from regional monopoly to competition in a wide area. The traditional electricity monopoly does not need as many transmission lines as the de-regulated market. Traditional electricity suppliers provide electricity to customers residing in their territory such as a part of Boston;

competitive suppliers supply electricity to any customers within a region, such as New England.

The blackout in north-eastern America is a good example of insufficient transmission networks and poor coordination among utilities and states. The blackouts started around 4 pm on August 14, 2003, and affected more than 50 million people in north-eastern American, in Ontario, Toronto, Cleveland, New York City, Buffalo, Albany, Long Island, Detroit, New Jersey, Vermont and Connecticut (U.S.-Canada Power System Outage Task Force, 2004).

The large area blackout started from First Energy Corporation (FE), which supplied electricity to Cleveland and Akron, Ohio. As the company's alarm system failed two hours before the blackout, FE could not know of any crucial problems with its transmission line with its own alert system. From 15:05:41 to 15:41:35 EDT, FE's three 345kV transmission lines heading to Cleveland and Akron failed because of contacts between sagged power lines and over-grown trees. Transmission lines severely sag when weather is hot and load is high. The failure of the three 345kV lines increased the load on the neighboring 125kV lines and caused voltages decrease. The neighboring 16 lines failed because of the increased load from 15:39 to 16:08 EDT. The trips of the 19 transmission lines caused blackout not only in the northern Ohio cities but also the whole of north-east America. Because of the high load and low voltage caused by the tripped line, regions including New York, Pennsylvania, New Jersey and Maryland disconnected from the other regions. Populated regions such as New York and Pennsylvania experienced blackouts when this happened because they could not import electricity from other states through the inter-state transmission lines (U.S.-Canada Power System Outage Task Force, 2004).

The institutional reason for the blackout is that Midwest Integrated System Operator (Midwest ISO)[11] did not have enough authority because it was in a developmental stage. If the Midwest ISO had enough authority, it could have prevented such a large-scale blackout. However, the 23 electric utilities that joined Midwest-ISO still controlled their own generation and transmission. Other ISOs centrally coordinate power generation and transmission of a wide area. For example, Integrated System Operator New England (ISO-NE) has the authority to control all the generation and transmission in the New England region (U.S.-Canada Power System Outage Task Force, 2004).

The economic reason for the blackout is that restructuring in Ohio caused insufficient transmission upgrades. Since the generation market was under competition, investment in power plants was more profitable than transmission, whose return rates are set by the regulator. Furthermore, former utilities were reluctant to invest in transmission because the "ceiling" on the transmission part of their retail rates. This ceiling could prevent new investments by causing liquidity constraints on the utility owners (Rosen, 2003).

The technical reason is that reactive power[12] was not sufficiently generated and stored in FE. Although reactive power is crucial to stable electricity operation, no one compensated the cost. Independent generators, who sell electricity not in their territory but in the market, did not have any incentive to generate reactive power under the remuneration system (U.S.-Canada Power System Outage Task Force, 2004).

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[11] It covers 13 US states such as Illinois, Ohio, Michigan, Kentucky, Missouri, Indiana, Virginia, Wisconsin, Iowa, and Minnesota

[12] Reactive power is defined as "the energy supplied to create or be stored in electric or magnetic fields in and around electrical equipment" by the U.S.-Canada Power System Outage Task Force (2003)

The US government struggled with the problem of market manipulation and insufficient coordination. When the Korean government privatizes KEPCO, it has to consider the possibility of market manipulation rather than insufficient coordination. As South Korea's transmission system is developed as one unit, the policy maker does not need to worry about connecting its transmission lines to create a big market. In other words, Korean transmission lines are already interconnected with each other. Since its establishment in 1961, KEPCO has networked the whole Korean mainland and its numerous islands, including Jeju Island, which is approximately 140km from the mainland. Today, KEPCO can remotely monitor and control all 715 substations in the country (KEPCO, 2010).

The possibility of market manipulation by significant privatized generation companies is bigger than the possibility of ill coordination of transmission lines in Korea. As this thesis argues in section 4.2, only several companies have enough scale to merge KEPCO's generation subsidiaries. If few companies supply generation services, they can implicitly and explicitly collude in a cartel. As shown in the 2000/2001 Eastern Energy Crisis, generators tend to collude to reduce production and raise electricity price to earn monopolistic profits.

5. CONCLUSION

This thesis investigates whether South Korea should privatize KEPCO. The first chapter discusses the current situation and the meaning of privatizing KEPCO. As shown in the first chapter, merely selling government's shares to private parties is not enough. The regulator has to develop a whole system of rules to guarantee market competition among the newly-privatized KEPCO and new comers in the market.

The second chapter discusses Chile, the United Kingdom and the United States. Each country has a different background for privatization and experience with privatization. While electricity prices declined in the UK, many researchers argue that a lot of problems are related to the decline. On the other hand, some researchers argue that the Chilean electricity market price skyrocketed as a result of the privatization.

Chapter 3 focuses on the benefits and costs of KEPCO privatization. First, the Korean government can earn up to ₩9.4 trillion by selling all of its shares of KEPCO. On the other hand, the government has to give up its control over the ₩93 trillion company which owns 88% of generation capacity, all transmission and distribution networks, and 29 subsidiaries worth ₩30 trillion.

The first part of the third chapter also discusses the challenge of finding new owners for KEPCO. Only eight chaebols have the financial ability to buy KEPCO. Selling KEPCO to the general public could prevent chaebols from dominating the electricity market. History, however, shows that selling KEPCO shares to low-income citizens does not always benefit them.

Chapter 3.3 deals with the possibility of obtaining loans and financial investment in the electricity industry. This thesis shows that foreign aid is not the right answer for South

Korea today, although foreign aid set the foundation of the country's electrification. Today, KEPCO obtains capital by issuing bonds in financial market. This thesis argues that investors are lending their money to KEPCO because KEPCO has shown stable operations and paid reasonable interest. This paper also argues that few investors will invest in the Korean electricity market if KEPCO is divided into small companies and sold separately.

Chapter 3.4 discusses whether electricity prices will go down after the privatization. The electricity prices of the UK, which privatized its state-owned electric utility in the 1990s, declined after the privatization. However, there are numerous critics of the price decline. First, the price decline is only beneficial to large consumers; electricity prices for large consumers went down 22 percent from 1990 to 2000, while those for small consumers went down merely 5 percent in the same period (Thomas, 2009). This thesis finds that privatized KEPCO would frequently raise electricity prices, which are currently lower than the costs. No shareholder would wait several years until the newly-privatized company makes a profit.

Chapter 3.5 investigates the ramifications of electricity privatization on the relationship between the government and market. This thesis argues that the government can offer discriminative electricity tariffs for specific industries after the privatization. This thesis also mentions, however, that the government influence on its electricity and related industries will decrease after the privatization of KEPCO. This paper proves the argument by showing that the government developed the nuclear power industry with KEPCO.

The last part of chapter 3 discusses transition costs from a monopoly by a state-owned utility to competition among private companies. This thesis argues that decision-makers should prepare more for market manipulation than for coordination. As Korea is

comparatively small and has an integrated network, it does not need to worry about a coordination problem. On the other hand, the country has to develop specific regulation to prevent market manipulation by a few new owners of KEPCO.

This thesis will be useful to researchers who want to approach the benefits and costs of KEPCO privatization from the point of academics. However, decision makers should also consider many aspects of privatization which are not discussed in this paper. For example, political and social considerations are important to painlessly implement the privatization. The government can obtain citizen supports by understanding which groups will be better off and informing the benefits to the group. The government could develop compensation policies for the people who are worse off, obtaining their support.

[Exhibit 1] KEPCO Subsidiaries

Affiliate	Ownership(%)	Book Value (Million Won)	Business
Korea Gas Corporation	24.5	1,330,534	Monopoly in importing LNG, distributes it to retailers
KEPCO KPS	80.0	342,606	Power plant maintenance and removal
LG Powercomm	38.8	326,096	Telecommunication
KEPCO Engineering & Construction	77.9	54,837	Power plant construction
Korea Hydro & Nuclear Power	100.0	13,945,112	Nuclear and Hydro power plant operation
Korea South-East Power Co.	100.0	2,185,930	Power plant operation
Korea Midland Power Co., Ltd.	100.0	2,497,639	Power plant operation
Korea Western Power Co., Ltd.	100.0	2,355,088	Power plant operation
Korea Southern Power Co., Ltd.	100.0	2,513,091	Power plant operation
Korea East-West Power Co., Ltd.	100.0	2,564,954	Power plant operation
KEPCO Nuclear Fuel Co., Ltd.	96.4	191,866	Nuclear Fuel
Korea Electric Power Industrial Development, Ltd.	49.0	26,553	Reading and recording electricity meters on a regular basis
Korea Electric Power Data Network Co., Ltd.	100.0	205,513	IT services related to electric power
Korea District Heating Co.	26.1	226,619	Supply massive-scale heating with heat obtained from generation
KEPCO International Hong Kong Ltd.	100.0	398,503	
KEPCO International Philippines	100.0	229,694	Generation (Coal-Power plant, Gas-power plant, Oil fired Plant)
KEPCO Gansu International Ltd.	100.0	18,746	Generation (Wind)
KEPCO Philippines Holdings Inc	100.0	55,582	Generation
KEPCO Asia International Ltd.	58.0	3	
KEPCO Lebanon SARL	51.0	738	Generation
KEPCO Neimenggu International	100.0	112,038	Generation (China, Wind)
KEPCO Shanxi International Ltd.	100.0	321,156	Generation (China, Wind)
KEPCO Australia Pty Ltd.	100.0	22,331	Coal production
KEPCO Canada Energy Inc.	100.0	54,456	Uranium exploration & production
KEPCO Netherlands B.V.	100.0	180,609	
KEPCO Energy Resource Nigeria	30.0	7,271	Oil exploration
KNOC Nigerian East Oil Co.	14.6	12	Oil exploration
KNOC Nigerian West Oil Co.	14.6	12	Oil exploration
Korea Imouraren Uranium Investment Corp.	60.0	173,048	Uranium production in Niger
Total		30,340,613	

Source: KEPCO, 2009

[Exhibit 2] Net generation by sector in the US in 2008

	Utility (A)	Independent Power Producers (B)	B/ (A+B) %		Utility (A)	Independent Power Producers (B)	B/ (A+B) %
New Jersey	-46	31,837	100%	Iowa	22,481	4,841	18%
Maine	0	5,603	100%	Oklahoma	27,575	5,920	18%
D.C.	0	101	100%	New Mexico	13,808	2,810	17%
Maryland	3	20,827	100%	Michigan	44,942	8,827	16%
Rhode Island	4	3,558	100%	Arkansas	23,815	4,417	16%
Connecticut	27	14,637	100%	Arizona	42,528	7,467	15%
Pennsylvania	681	106,871	99%	Virginia	30,158	5,118	15%
Massachusetts	304	20,068	99%	Washington	42,302	7,064	14%
Illinois	2,607	93,242	97%	Alabama	63,891	9,766	13%
Delaware	NM	2,661	95%	Minnesota	23,052	3,300	13%
Vermont	418	2,739	87%	Indiana	51,157	6,705	12%
New Hampshire	2,128	8,097	79%	South Dakota	3,638	351	9%
Montana	3,005	11,194	79%	North Dakota	15,355	1,463	9%
Texas	44,509	131,993	75%	Florida	98,195	8,049	8%
New York	17,077	46,969	73%	Georgia	59,082	4,771	7%
California	42,477	44,155	51%	Kentucky	44,905	2,997	6%
Mississippi	14,574	9,373	39%	Kansas	22,572	1,307	5%
Hawaii	3,024	1,800	37%	Wyoming	21,174	1,068	5%
Nevada	11,015	5,958	35%	North Carolina	59,495	2,546	4%
Ohio	46,167	21,933	32%	Utah	20,300	650	3%
Louisiana	23,214	11,007	32%	Alaska	3,083	79	2%
West Virginia	29,807	12,364	29%	Missouri	43,686	751	2%
Wisconsin	22,830	7,883	26%	South Carolina	49,851	640	1%
Idaho	3,986	1,195	23%	Nebraska	17,362	108	1%
Colorado	18,667	5,555	23%	Tennessee	39,622	126	0%
Oregon	20,840	5,923	22%	**Total**	**1,191,347**	**718,684**	**38%**

Source: author, data from EIA (http://www.eia.doe.gov/cneaf/electricity/epm/table1_6_a.html)

[Exhibit 3] 2010 retail price by state, by de-regulation in the US (cents/kilowatt-hour)

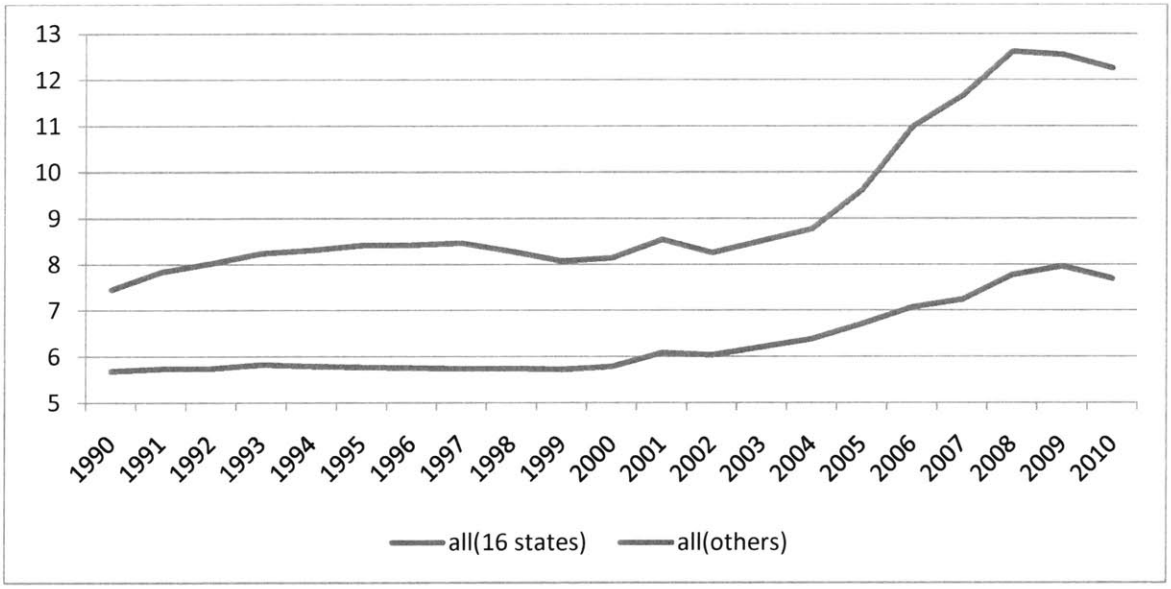
Rank	State	price (C/kWh)	rank	state	price (C/kWh)	rank	state	price (C/kWh)
1	Hawaii	25.33	18	Michigan	10.42	35	South Carolina	8.58
2	Connecticut	17.33	19	Nevada	10.23	36	South Dakota	8.14
3	New York	17.15	20	Colorado	9.98	37	Nebraska	8.11
4	New Jersey	15.65	21	Wisconsin	9.97	38	Oklahoma	8.07
5	Alaska	15.39	22	Texas	9.77	39	Arkansas	7.84
6	New Hampshire	14.63	23	Illinois	9.58	40	Iowa	7.81
7	Rhode Island	14.56	24	Georgia	9.41	41	North Dakota	7.7
8	Massachusetts	14.46	25	Ohio	9.35	42	Oregon	7.69
9	California	14.41	26	Alabama	9.17	43	Louisiana	7.62
10	District of Columbia	13.89	27	New Mexico	8.96	44	Utah	7.58
11	Vermont	13.17	28	Missouri	8.86	45	Montana	7.47
12	Maryland	13.12	29	Mississippi	8.83	46	Indiana	7.47
13	Delaware	12.34	30	Tennessee	8.81	47	West Virginia	7.14
14	Maine	12.29	31	Virginia	8.78	48	Kentucky	6.87
15	Florida	10.72	32	Minnesota	8.68	49	Idaho	6.69
16	Arizona	10.52	33	North Carolina	8.63	50	Washington	6.52
17	Pennsylvania	10.48	34	Kansas	8.62	51	Wyoming	6.12

Source: retail price: EIA (http://www.eia.doe.gov/cneaf/electricity/epm/table5_3.html)
Restructuring: EIA (http://www.eia.doe.gov/cneaf/electricity/page/restructuring/restructure_elect.html)

[Exhibit 4-1] comparison of average retail prices in the US (October, 2010)

	16 states	35 other states
Average Retail Price Residential (c/kWh)	12.18	10.51
Average Retail Price Commercial (c/kWh)	10.72	9.24
Average Retail Price Industrial (c/kWh)	8.6	6.95

[Exhibit 4-2] Average Retail Prices in the US (c/kWh)



[Exhibit 4-3] Electricity price increase rate in the US (%, all sectors)

	all(16 states)	all(others)
90→00	9.3%	1.8%
00→10	50.5%	33.0%
90→10	64.4%	35.4%

[Exhibit 4-4] Electricity price increase rate in the US (%, residential sector)

	residential(16 states)	residential (others)
90→00	11.9%	4.8%
00→10	40.0%	22.1%
90→10	56.6%	28.0%

[Exhibit 4-5] Electricity price increase rate in the US (%, commercial sector)

	commercial(16 states)	commercial (others)
90→00	5.3%	-0.8%
00→10	43.8%	27.8%
90→10	51.3%	26.8%

[Exhibit 4-6] Electricity price increase rate in the US (%, industrial sector)

	industrial(16 states)	industrial (others)
90→00	0.9%	-2.4%
00→10	62.9%	37.8%
90→10	64.3%	34.6%

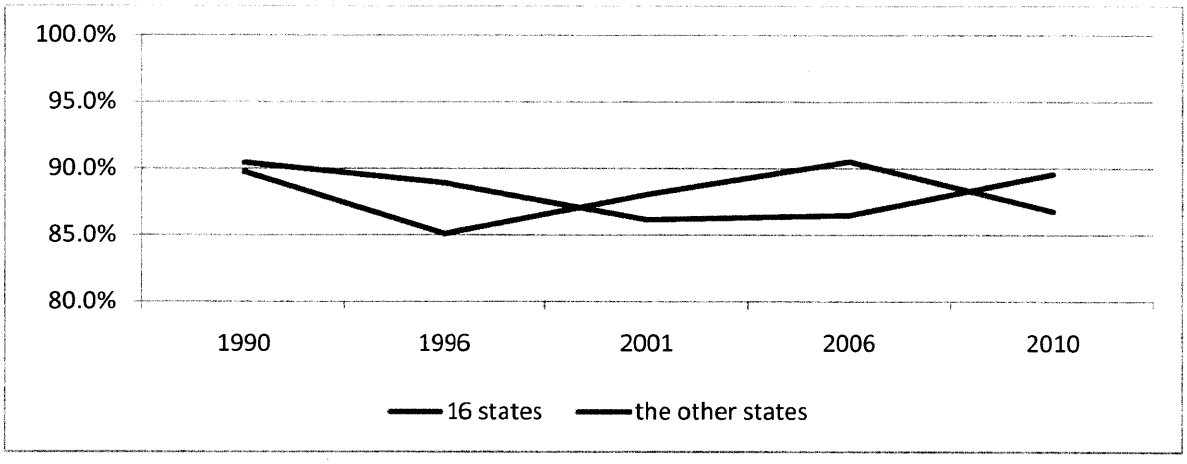
[Exhibit 4-7] Residential, commercial and relative commercial service price in the US

Year	16 states			Other states		
	Residential	Commercial	Relative	Residential	Commercial	Relative

	(A)	(B)	commercial price*	(A)	(B)	commercial price*
1990	8.68	7.79	89.7%	6.9	6.24	90.4%
1996	10.11	8.6	85.1%	7.12	6.33	88.9%
2001	9.94	8.75	88.0%	7.43	6.4	86.1%
2006	12.22	11.06	90.5%	8.57	7.41	86.5%
2010	13.59	11.79	86.8%	8.83	7.91	89.6%

*Relative commercial price: (B/A)%

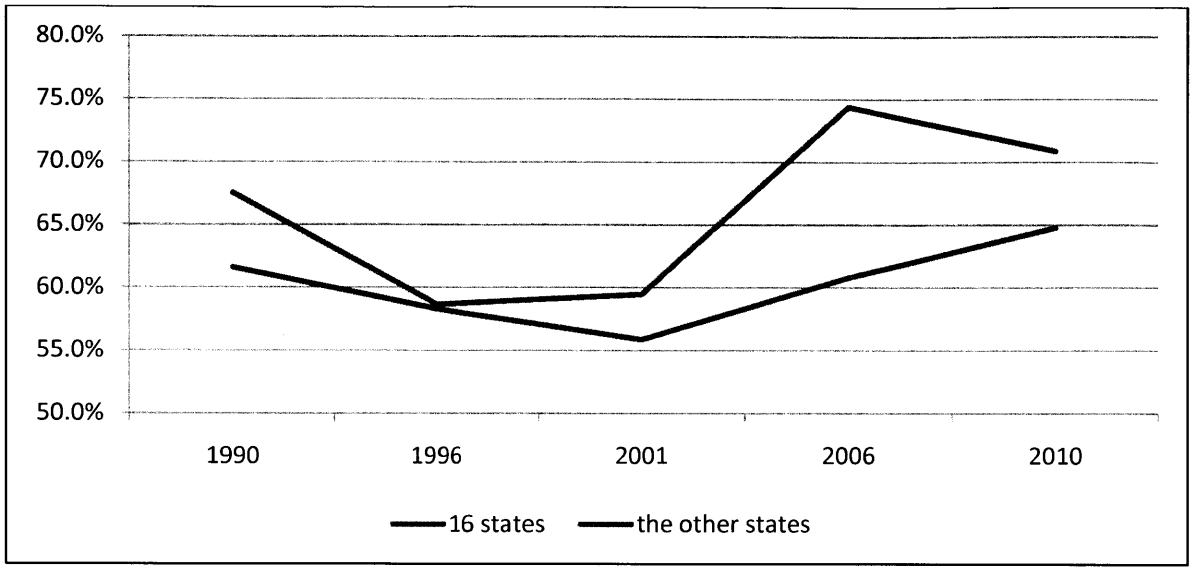
[Exhibit 4-8] The trend of relative commercial service prices in the US



[Exhibit 4-9] Residential, industrial and relative industrial price in the US (cents/kWh, %)

Year	16 states			Other states		
	Residential (A)	Industrial (B)	Relative industrial price*	Residential (A)	Industrial (B)	Relative industrial price*
1990	8.68	5.86	67.5%	6.9	4.25	61.6%
1996	10.11	5.93	58.7%	7.12	4.15	58.3%
2001	9.94	5.91	59.5%	7.43	4.15	55.9%
2006	12.22	9.09	74.4%	8.57	5.21	60.8%
2010	13.59	9.63	70.9%	8.83	5.72	64.8%

[Exhibit 4-10] The trend of relative industrial service prices in the US



[Exhibit 5] The 30 biggest Korean companies (stock market value)

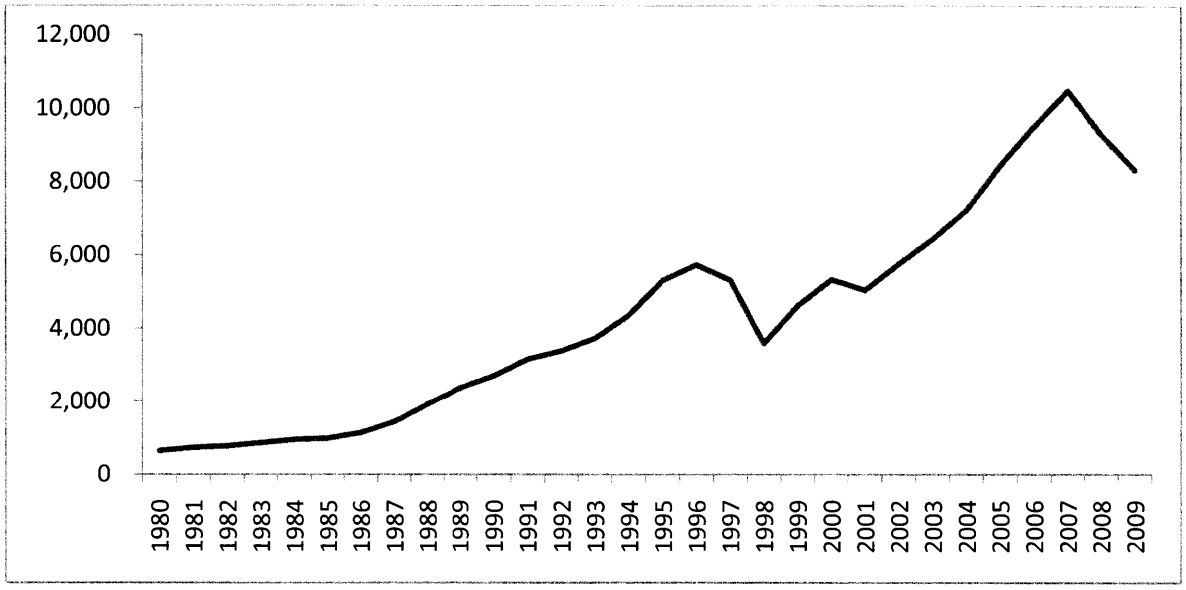
Unit: ₩ 100 million

Ranking	Company	Market Value (Feb16, 2011)	Asset Value (Dec.31, 2010)	Ranking	Company (Feb16, 2011)	Market Value
1	Samsung Electronics	1,334,532	1,342,887	16	S-Oil	133,411
2	Hyundai Motors	402,005	914,630	17	LG	133,042
3	POSCO	398,880	503,117	18	SK Telecom	130,808
4	Hyundai Heavy Industrial	335,540	364,601	19	LG Display	128,456
5	Hyundai Mobis	271,589	142,012	20	Lotte Shopping	120,530
6	LG Chemicals	255,806	126,734	21	Woori Finance	113,245
7	KIA Motors	250,843	259,628	22	Samsung Fire Ins.	112,515
8	Shinhan Holdings	234,255	2,550,180	23	Honam Petrolium	111,351
9	KB Finance	221,766	2,621,684	24	Hyundai Steel	109,203
10	Samsung Life Ins.	214,000	1,331,612	25	Samsung C&T	103,885
11	KEPCO	177,073	932,080	26	KT	103,139
12	SK Innovation	174,760	246,672	27	Hana Finance Holdings	101,159
13	Hynix	170,591	163,035	28	Samsung Electro Mechanics	98,222
14	LG Electronics	164,175	323,185	29	Shinsegae	98,075
15	Samsung Electronics (Preference Shares)	139,056	68,359	30	Industrial Bank of Korea	93,639

Source: Korea Stock Exchange

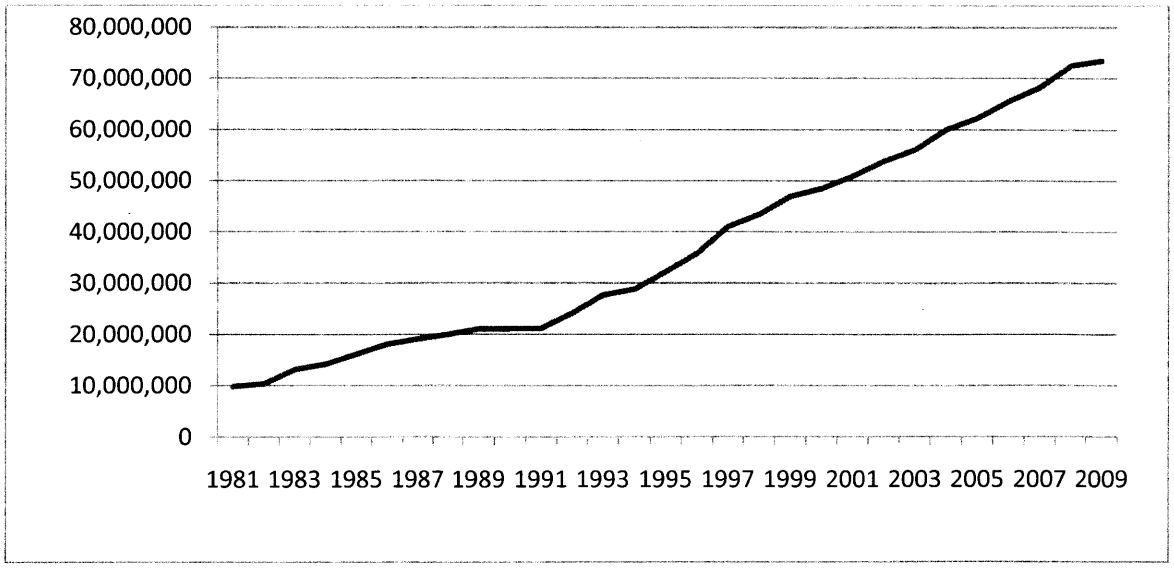
[Exhibit 6] Korean GDP and generation capacity

Korean GDP (Hundred Million US $)



Source: The bank of Korea website (www.bok.go.kr)

Generation Capacity (kWh)



Source: MKE, 2011a

[Exhibit 7] The world electricity generation

Terawatt-hours	1990	1995	change 1995 over 1990	2000	change 2000 over 1995	2005	change 2005 over 2000
US	3185.4	3516.8	10.4%	3990.5	13.5%	4257.4	6.7%
Canada	482.0	559.6	16.1%	604.8	8.1%	597.2	-1.2%
Argentina	50.9	67.2	31.9%	89.0	32.5%	105.5	18.6%
Brazil	222.8	275.6	23.7%	348.9	26.6%	402.9	15.5%
Chile	18.4	26.7	45.6%	40.1	49.9%	54.5	35.9%
Austria	50.4	56.6	12.2%	61.8	9.2%	60.6	-1.9%
Czech Republic	62.6	60.8	-2.7%	73.5	20.7%	82.6	12.4%
Denmark	25.8	36.6	42.1%	35.8	-2.1%	36.0	0.5%
Finland	54.0	63.2	17.0%	70.0	10.7%	70.3	0.4%
France	420.2	493.9	17.6%	540.8	9.5%	576.2	6.5%
Germany	549.9	534.7	-2.8%	564.5	5.6%	620.3	9.9%
Greece	35.0	41.6	18.7%	53.8	29.6%	60.0	11.5%
Hungary	28.4	34.0	19.7%	35.2	3.5%	35.8	1.6%
Iceland	4.5	5.0	10.3%	7.7	54.3%	8.7	13.0%
Republic of Ireland	14.5	17.9	23.2%	24.0	34.1%	26.0	8.3%
Italy	216.9	241.5	11.3%	276.6	14.6%	303.7	9.8%
Poland	136.4	139.0	1.9%	145.2	4.4%	156.9	8.1%
Portugal	28.5	33.3	16.7%	43.8	31.6%	46.6	6.4%
Romania	63.8	59.3	-7.1%	51.9	-12.4%	59.4	14.4%
Russian Federation	1082.2	862.1	-20.3%	877.8	1.8%	953.1	8.6%
Slovakia	24.0	25.9	7.9%	30.7	18.5%	31.5	2.5%
Spain	151.7	168.9	11.3%	224.8	33.1%	294.1	30.8%
Sweden	146.5	147.6	0.8%	145.8	-1.3%	158.4	8.7%
Switzerland	55.8	63.1	13.0%	67.4	6.8%	59.8	-11.3%
Turkey	57.5	86.2	49.9%	124.9	44.8%	162.0	29.7%
Turkmenistan	14.6	9.8	-32.9%	9.8	0.5%	12.8	30.2%
Ukraine	298.5	194.0	-35.0%	169.0	-12.9%	185.0	9.5%
United Kingdom	319.7	337.4	5.5%	377.1	11.7%	398.4	5.6%
Uzbekistan	56.3	47.4	-15.8%	46.8	-1.3%	47.7	1.9%
Iran	57.7	84.4	46.3%	119.3	41.5%	169.7	42.2%
Kuwait	18.5	23.7	28.4%	32.9	38.5%	43.7	33.1%
Qatar	4.8	6.0	24.2%	9.1	51.9%	14.4	57.6%
Saudi Arabia	70.1	99.9	42.4%	126.2	26.4%	175.0	38.7%
South Africa	165.4	188.1	13.8%	210.7	12.0%	244.9	16.3%
Bangladesh	8.3	12.1	45.5%	15.8	30.1%	22.6	43.7%
China	621.2	1006.6	62.0%	1355.6	34.7%	2500.3	84.4%
China Hong Kong SAR	29.0	27.9	-3.6%	31.3	12.2%	38.4	22.7%
India	296.0	422.7	42.8%	565.4	33.8%	708.7	25.3%
Indonesia	33.3	58.9	76.6%	92.6	57.3%	127.4	37.5%
Japan	841.1	968.6	15.2%	1057.9	9.2%	1133.6	7.2%
Malaysia	25.3	46.6	84.6%	66.7	43.0%	96.2	44.3%
New Zealand	32.1	36.0	12.0%	39.3	9.1%	43.0	9.4%
Pakistan	46.0	63.8	38.6%	64.7	1.4%	87.1	34.7%
Philippines	26.3	33.6	27.5%	45.3	35.0%	56.6	24.9%
Singapore	15.6	22.1	41.2%	31.7	43.6%	38.2	20.7%
South Korea	**118.7**	**205.1**	**72.7%**	**295.2**	**43.9%**	**396.6**	**34.4%**
Taiwan	90.2	133.1	47.6%	184.9	38.9%	227.4	23.0%
Thailand	46.2	83.7	81.2%	96.0	14.7%	132.2	37.7%
Total World	**11865.4**	**13272.9**	11.9%	**15401.2**	16.0%	**18301.8**	18.8%
OECD	7586.0	8481.2	11.8%	9625.1	13.5%	10427.1	8.3%

Source: EIA website (www.eia.doe.gov)

[Exhibit 8] KEPCO's Moody's and S&P credit ratings

Date of comment	Moody's	Date of comment	S & P
2010.04	A1	2005.07	A
2009.03	A2	2002.07	A-
2006.05	A1	2002.06	BBB+
2003.01	A3	1999.11	BBB
2002.05	Baa2	1999.01	BBB-
1999.03	Baa3	1998.04	BB+
1997.11	A3	1997.12	B+
1992.06	A1	1997.11	A-
		1997.10	A+
		1995.05	AA-
		1992.06	A+

Source: KEPCO website

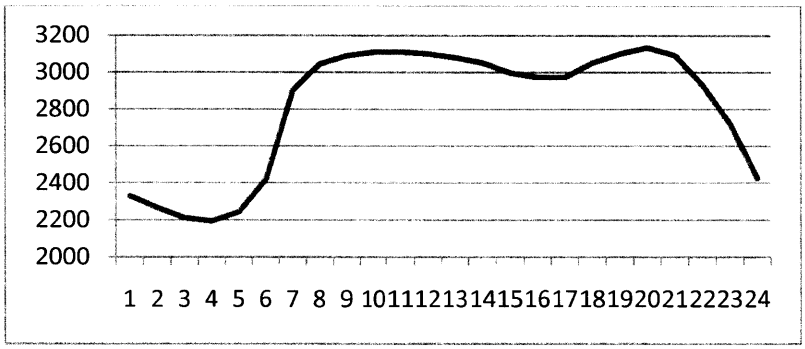
[Exhibit 9] Nuclear Power plants in Korea

Era	Name	Begin Construction	Begin Operation
1st Era 100% Foreign technologies Foreign drive - Turnkey Contract	Kori #1	1970	1978
	Wolsung#1	1976	1983
	Kori#2	1977	1983
2nd Era Developing Domestic Technology KEPCO drive Non-turnkey contract	Kori#3	1978	1985
	Kori#4	1978	1986
	Youngkwang#1	1980	1986
	Youngkwang#2	1980	1987
	Woljin #1	1981	1988
	Woljin #2	1981	1989
3rd Era 95% domestic technology	Youngkwang #3	1989	1995
	Youngkwang#4	1989	1996
	Wolsung#2	1991	1997
	Wolsung#3	1992	1998
	Wolsung#4	1992	1999
4th Era Korea Standard Nuclear Power Plants (OPR 1000) Advanced Korea Standard Nuclear Power Plants (APR1400)	Woljin #3	1992	1998
	Woljin#4	1992	1999
	Woljin#5	1999	2004
	Woljin#6	1999	2005
	Youngkwang#5	1996	2002
	Youngkwang#6	1996	2002
	Sin-Gori #1	2005	2011
	Sin-Gori #2	2005	2011
	Sin-Wolsung#1	2005	2012
	Sin-Wolsung#2	2005	2013
	Sin-Gori #3	2007	2013
	Sin-Gori #4	2007	2014
	Sin-Woljin #1		2016
	Sin-Woljin#2		2017

Source: MKE, 2011b

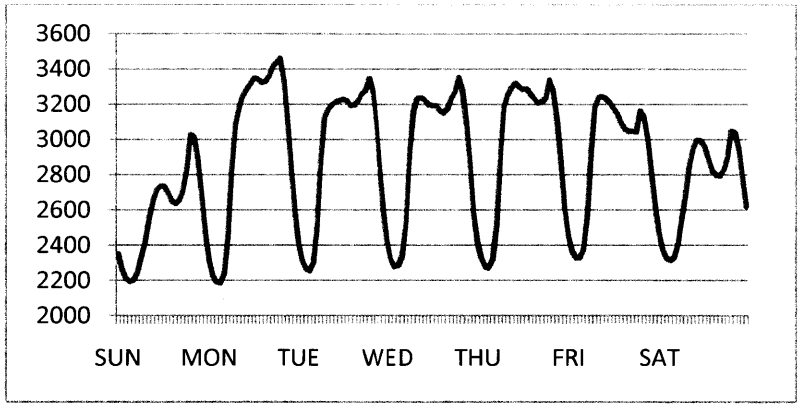
[Exhibit 10] Electricity demand

Hourly Electricity Demand in Massachusetts in March 29, 2011



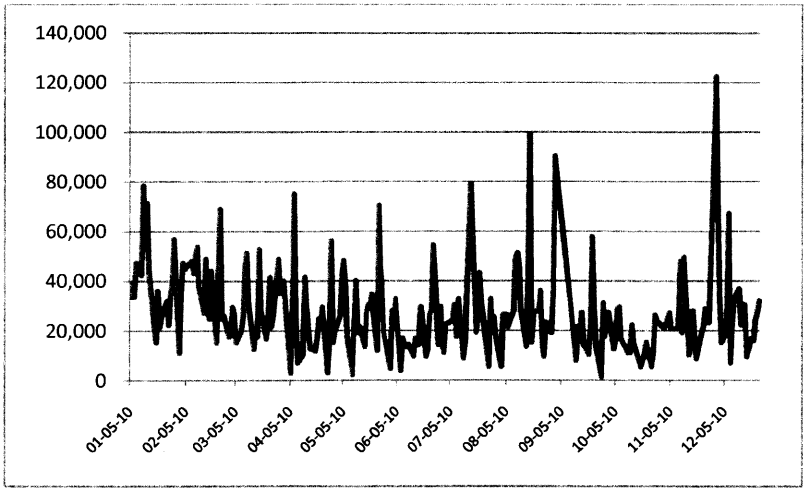
Data: ISO-NE (http://www.iso-ne.com/markets/hrly_data/selectHourlyLoad.do#anchor2)

Weekly Electricity Demand in Massachusetts from March 20 to 26 (Sun. to Sat), 2011



Data: ISO-NE (http://www.iso-ne.com/markets/hrly_data/selectHourlyLoad.do#anchor2)

Annual Electricity Demand in New England (MWh) in 2010



Data: EIA (http://www.eia.doe.gov/cneaf/electricity/wholesale/wholesale.html)

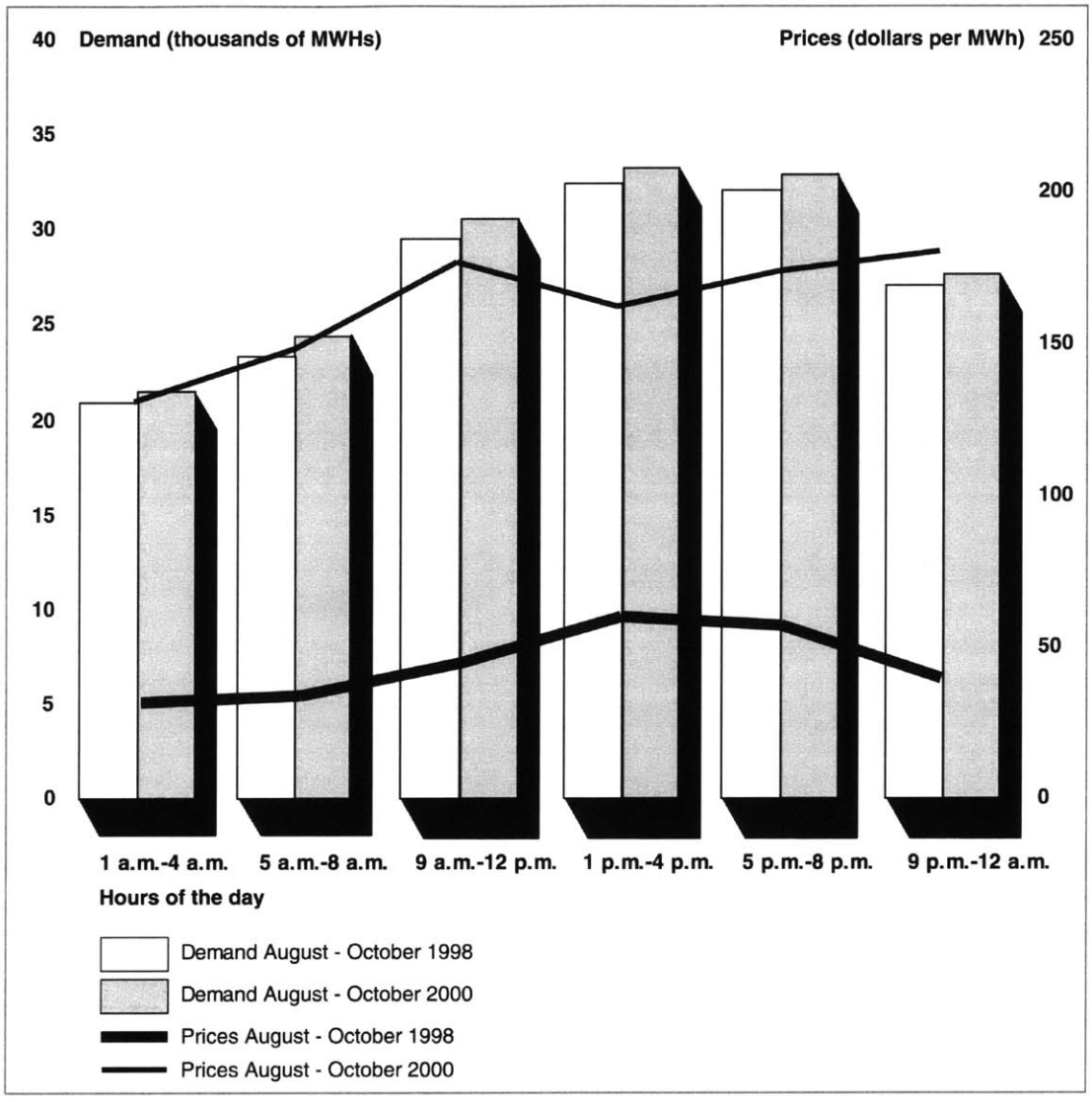
[Exhibit 11] World electricity statistics

Country	2008 Total Electricity Generation (TWh)	2008 Total Electricity Generation Capacity (GW)	2008 Retail Price for Household ($/kWh)	2008 Steam Coal Price for electricity generation ($/Sq. Ton)	2008 Heavy Fuel Oil Prices for Electricity Generation ($/Sq. Ton)	2008 Natural Gas Prices for Electricity Generation ($/Million Kilocalories)	2008 Electricity Distribution Losses (Billion kWh)
Argentina	115.41894	30.96539	0.023 (2007)	NA	NA	NA	16.175
Australia	242.2236	55.511	0.098 (2004)	NA	NA	NA	16.848
Austria	61.9222	20.797	0.201	122.10	342.3	NA	3.449
Barbados	1.011	0.2391	NA	NA	NA	NA	0.066
Belgium	78.4413	16.76	NA	130.54	160.4 (2002)	NA	4.262
Bolivia	5.9817	1.45401	NA	NA	NA	NA	0.804
Brazil	454.82956	103.9606	0.171	NA	NA	NA	77.081
Canada	632.227	127.644	0.078 (2006)	26.29 (2006)	222.4 (2006)	218.7 (2006)	50.518
Chile	60.281	13.145	0.195	NA	NA	NA	5.081
china	3221.1811	797.078	NA	NA	NA	NA	191.829
Colombia	51.01477	13.3955	0.135	NA	NA	NA	10.798
Costa Rica	9.2895	2.36966	0.097	NA	NA	NA	0.973
Croatia	11.6579	3.908	0.107 (2007)	NA	NA	NA	1.706
Cuba	16.9904	5.3962	NA	NA	NA	NA	2.787
Cyprus	4.7092	1.119	NA	NA	304.6 (2006)	NA	0.153
Czech Republic	78.4343	17.739	0.191	NA	438.4	197.7959 (2003)	4.662
Denmark	34.3174	12.495	0.396	NA	NA	C	2.358
Dominican Republic	14.5765	5.5182	0.136	NA	NA	NA	1.711
Ecuador	18.0611	4.189	0.094	NA	NA	NA	3.774
El Salvador	5.7208	1.5259	NA	NA	NA	NA	0.107
Finland	73.6479	16.648	0.172	142.90	577	340.1	3.334
France	541.8663	117.822	0.169	136.10	NA	NA	32.916
Germany	594.6854	139.276	0.263 (2007)	152.60	572.1	NA	30.118
Greece	58.9681	14.253	0.112 (2005)	NA	NA	C	5.053
Guatemala	8.3954	2.29	NA	NA	NA	NA	1.216
Guyana	0.466	0.309	NA	NA	NA	NA	0.132
Haiti		0.244	NA	NA	NA	NA	0.257
Honduras	6.2611	1.593	NA	NA	NA	NA	1.346

Hungary	37.8052	8.63	0.224	NA	NA	623.7	3.888
India	785.52885	177.37552	0.047 (2005)	24.25	665.3	NA	193.741
Indonesia	141.1852	27.8016	0.061	NA	449.6 (2006)	66.54 (2006)	15.038
Ireland	27.4745	7.402	0.267	99.46	566.1	C	2.248
Israel	53.0385	11.69	0.098 (2006)	NA	NA	NA	2.215
Italy	294.9682	98.626	0.305	NA	C	C	20.444
Jamaica	7.3232	1.162	NA	NA	NA	NA	0.923
Japan	1015.1652	280.533	0.206	39.593 (2002)	NA	NA	51.313
Kazakhstan	75.879	18.734	0.052	NA	NA	NA	7.114
Korea	418.1545	79.859	0.089	91.00	339.3 (2004)	675.6	16.106
Luxembourg	2.2425	1.669	0.215	NA	NA	NA	0.136
Mexico	245.51648	57.231	0.096	52.41	443.9	422.9	43.011
Netherlands	101.3445	24.875	0.243	NA	NA	NA	4.659
New Zealand	42.27544	9.376	0.164	NA	C	C	3.254
Nicaragua	3.41928	0.94817	0.172	NA	NA	NA	0.801
Norway	139.6553	30.788	0.164	NA	NA	NA	10.235
Panama	6.2431	1.654	0.165 (2007)	NA	NA	NA	0.908
Paraguay	54.912	8.136	0.072	NA	NA	NA	2.914
Peru	31.9212	7.1577	0.134	NA	NA	NA	2.658
Poland	146.1054	32.677	0.193	79.20	486.8	NA	12.685
Portugal	43.0225	15.763	0.22	150.40	478.4	519.3	4.184
Romania	62.0285	21.753	0.114 (2005)	NA	NA	NA	7.19
Russia	984.4903	224.2404	NA	NA	NA	NA	109.24
Singapore	39.214	10.95	0.19	NA	NA	NA	2.107
Slovak Republic	27.3309	7.357	0.22	NA	NA	622.7	1.003
South Africa	238.30278	44.0744	0.059 (2006)	10.34 (2005)	NA	NA	0.02205
Spain	293.5026	93.525	0.218	NA	270.4 (2003)	NA	15
Sweden	145.0588	33.943	NA	NA	NA	NA	10.985
Switzerland	64.3775	7.872	0.154	NA	NA	NA	4.317
Thailand	138.986	40.669	0.094	NA	NA	NA	8.954
Turkey	188.8392	41.818	0.165	32.34	999.2	572.0	27.481
United Kingdom	361.8421	85.605	0.231	82.32 (2007)	533.4	358.8	28.195
United States	4119.387	1010.172	0.113	46.99	603	362.4	245.88146

Source: EIA website (www.eia.doe.gov)

[Exhibit 12] Comparison of prices and demands



Source: GAO, 2001

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